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Accident Research Centre

**EVALUATION OF ASSOCIATIVE
LEARNING METHODS TO TRAIN
DRIVERS TO GIVE WAY TO
MOTORCYCLISTS**

By
Simon Hosking
Christine Mulvihill
Jessica Edquist
Michael Lenné
Karen Stephan
Mark Symmons
Cameron Murdoch
Jeff Archer

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Authors:

Simon Hosking, Christine Mulvihill, Jessica Edquist, Michael Lenné, Karen Stephan, Mark Symmons, Cameron Murdoch and Jeff Archer

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Abstract:

A high proportion of motorcycle casualty crashes involve drivers failing to give way to on-coming motorcycle riders at intersections. Previous research has shown that associative learning interventions can be used to successfully change driving-related decisions by manipulating learned relationships between crash risk and motorcycles. For example, Harrison (2005) demonstrated that the effect of increasing the crash risk associated with approaching motorcycles in a PC-based task led to increased wait responses to photographs of motorcycles at intersections, and that these effects were maintained in a four-week follow-up test. The present experiment was a partial replication and extension of Harrison's study that aimed to (i) assess the associative learning approach in dynamic learning situations where the task was more representative of real driving, (ii) demonstrate transfer of learning from the static learning contexts to dynamic contexts that more closely simulate the judgements made when turning at intersections, and (iii) test the longevity of learning after a period of 12 weeks after a training phase. The results replicated Harrison's finding that associative learning interventions increase the likelihood of drivers to respond that they would wait for approaching motorcycles at intersections. However, such learned avoidance responses only occurred when the associative learning intervention used photographic stimuli, and the increase in learned wait responses that occurred for photographic stimuli in the initial phase of the experiment was extinguished in a follow-up test using video stimuli. When the intervention used video stimuli, there was no evidence of increased avoidance responses to motorcycles. Rather, the probability of a wait response to cars decreased in a manner that was consistent with inhibitory learning, and this latter effect persisted in a four-week follow up test. On the basis of these results, an additional 12 week evaluation was not conducted. Conclusions and recommendations about the associative learning technique, and other methodologies, for training drivers to give way to motorcycle riders at intersections are provided.

Key Words:

Associative Learning; Motorcycle safety;
Intersection crashes

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Monash University Accident Research Centre,
Building 70, Clayton Campus, Victoria, 3800, Australia.
Telephone: +61 3 9905 4371, Fax: +61 3 9905 4363

Preface

Project Manager / Team Leader:

Dr Simon Hosking

Research Team:

- Ms Christine Mulvihill
- Ms Jessica Edquist
- Dr Michael Lenné
- Ms Karen Stephan
- Dr Mark Symmons
- Mr Cameron Murdoch
- Dr Jeff Archer

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EXECUTIVE SUMMARY

A high proportion of motorcycle casualty crashes involve drivers failing to give way to oncoming motorcycle riders at intersections. The potential value of an associative learning approach to modifying the decision making of drivers when making right turns across oncoming traffic at intersections has been reported by Harrison (2002; 2005). By exposing drivers to computer-presented learning trials in which there was an increased risk of a crash associated with photographs of oncoming motorcycles at intersections, Harrison found that drivers were more likely to respond that they would wait at the intersection rather than turn. Harrison (2005) demonstrated that the effect of the associative learning intervention on drivers' wait responses was larger for novice drivers than experienced drivers, and that the effect had not diminished after a period of four weeks.

Harrison's (2005) results suggest that an associative learning approach to driver training programs using PC-based multimedia may be effective at reducing the likelihood that drivers would turn across the path of motorcycles at intersections in real-world contexts. However, further research is required before such an approach could be applied in formal training programs. First, a replication of Harrison's findings using dynamic video stimuli would provide an assessment of whether any learning effect would occur in situations that more closely resemble real-world driving. Second, while Harrison used photographs to train and test drivers, a transfer of learning in static contexts to dynamic contexts would need to be demonstrated. Third, while Harrison demonstrated that the effect of the associative learning training was maintained at four weeks, a longer term learning effect would provide further justification for the development of a training program using associative learning methodologies.

The findings of the present study replicated those reported by Harrison (2002; 2005) in that the associative learning intervention increased the likelihood of drivers' responding that they would wait for approaching motorcycles at intersections. However, such learned avoidance responses only occurred when the associative learning intervention used photographic stimuli, and the increase in learned wait responses that occurred for photographic stimuli in the initial phase of the experiment was extinguished in a follow-up test using video stimuli. When the intervention used video stimuli, there was no evidence of increased avoidance responses to motorcycles. Rather, the probability of a wait response to cars decreased in a manner that was consistent with inhibitory learning, and this latter effect persisted in a four-week follow up test. Overall, the results found that avoidance learning does not appear to occur in dynamic contexts where the task is more representative of real-world driving. Furthermore, the study was unable to demonstrate transfer of avoidance learning from the static learning contexts to dynamic contexts. On the bases of these results, it was recommended not to proceed with a 12-week test to investigate the longevity of associative learning in dynamic contexts.

An alternative task was carried out that involved making conclusions and recommendations about the associative learning technique, and other methodologies, for training drivers to give way to motorcycle riders at intersections. The revised task was designed to provide possible explanations for why the associative learning intervention was unsuccessful for the video trials, and provide suggestions for future experiments.

The review noted that Harrison's (2005) use of associative learning to train drivers to be more likely to give way to motorcycles at intersections was an interesting application of psychological theory to road safety research. Through a series of experiments he was able

to demonstrate that, in experimental settings where many of the dynamic cues used in driving were not available to drivers, manipulations of crash risk associated with the presence of a motorcycle at an intersection could be used to increase their cautionary responses.

When drivers' responses were made in dynamic contexts that more realistically approach those of real-world driving, such as the videos used in the present study, then random manipulations of crash risk at intersections with motorcycles fails to take into account the complex interactions of factors that can lead to a crash. That is, the presence of a motorcycle per se does not increase crash risk, but rather, crash risk varies as a function of the dynamics of the motorcycle, the skill level of the driver, the presence of other vehicles and objects on the road, and environmental conditions. A driver must take all of these factors into account when deciding whether or not to turn, and a motorcycle crash will occur if the driver turns in front of a motorcycle under conditions where a crash cannot be avoided. It was proposed that, in the video task used in the present study, randomly assigning crash risk for approaching motorcycles caused a conflict between feedback and the perceptual experience of the driver. It is likely that this conflict led to the absence of any associative learning effect for video-based stimuli that would benefit road-safety.

It was concluded that associative learning is likely to be more appropriate for changing drivers' responses to static stimuli, such as photographs of oncoming traffic, which reduce the complexity of actual driving environments. The more dynamic and realistic the training stimuli become, the greater the information processing demands/requirements and the greater the likelihood that the stimulus-response relationship will be confounded by broader perceptual and cognitive demands.

Two alternative methodologies for training drivers to give way to motorcycles at intersections have been proposed. The first proposal is for a perceptual learning methodology that provides feedback to drivers about their responses that is based on the real world factors that lead to intersection crashes. This methodology is theoretically sound, and training of this form in other related settings has been linked with safer real-world behaviour. The second proposal is to further investigate the usefulness of Harrison's (2002; 2005) approach, by investigating the effectiveness of associative learning using static training stimuli, but using a more ecologically valid context of a simulator to test whether the learned responses transfer to actual turning behaviour.

1 INTRODUCTION

1.1 BACKGROUND

A high proportion of motorcycle casualty crashes at road intersections involve drivers making right turns but failing to give way to on-coming motorcycle riders. Harrison (2001) discussed several psychological mechanisms that could explain crashes in which drivers turn across the path of oncoming motorcyclists. He concluded that an associative learning mechanism was worth considering as the basis for understanding the behavioural decision-making that underlies this behaviour, and as the basis for developing an intervention program that could be presented in a training context for novice drivers (Harrison, 2005).

Harrison (2002) reported the potential value of an associative learning approach to modifying the decision making of drivers when making right turns across oncoming traffic at intersections. By exposing drivers to PC-based learning trials in which the probability of a crash in a right-turning task at intersections was increased when turning in front of an oncoming motorcycle, Harrison found that drivers were more likely to respond that they would wait for oncoming motorcycles. In a replication and extension of these findings, Harrison (2005) demonstrated that the effect of the learning methodology on drivers' wait responses was larger for novice/inexperienced (i.e., learner and probationary) drivers than experienced drivers, and that the effect had not diminished after a period of four weeks.

Harrison's (2005) results suggest that a training program could be implemented using PC-based multimedia that could reduce the likelihood that drivers would turn across the path of motorcycles at intersections in real-world driving. However, before such a program could be formally applied, further research was recommended to assess its effectiveness. First, replication of Harrison's findings using dynamic video stimuli would provide an assessment of whether any learning effect could be extended to situations that more closely resemble real-world driving. Second, demonstrating that the associative learning effect obtained in static contexts could be transferred to responses to videos of approaching motorcycles would provide evidence of the potential of the associative learning intervention to influence turning decisions in contexts that represent those of real-world driving. Third, while Harrison demonstrated that the effect of associative learning was maintained after four weeks, a longer term learning effect would provide further justification for the development of a training program using associative learning methodologies.

In summary, the overall aim of the project was to further evaluate the potential of an associative learning intervention for training car drivers to give way to motorcyclists. The two aims to be addressed specifically are:

- to investigate further the effectiveness of associative learning in dynamic contexts that more closely represent real driving; and
- to confirm the longevity of avoidance learning after a period of 12weeks.

2 ASSOCIATIVE LEARNING

2.1 ASSOCIATIVE LEARNING AND DRIVING

Associative learning describes a psychological mechanism by which associations are formed between events, behaviours, and consequences (Walker, Burnham & Borland, 1994). Avoidance learning is a type of associative learning that can play an important role in preventing organisms from approaching dangerous situations (e.g., Miller, 1948). Several researchers (e.g., Parsons, 1976; Fuller, 1984; 1998; 1992) have argued that avoidance learning plays an important role in drivers' learning to avoid dangerous outcomes such as collisions. For example, a new driver following too closely to the vehicle in front might learn that the sudden appearance of that vehicle's brake lights can result in a rear-end collision and learn to avoid a collision by maintaining a safe following distance before the dangerous situation arises. Drivers appear to respond to signals that predict negative situations in order to avoid them, and it is argued that associative learning is the mechanism that facilitates the learning of such avoidance behaviour (Harrison, 2005).

Harrison (2001) argued that a failure of avoidance learning may account for the high crash risk associated with turning right across the path of an oncoming motorcycle rider. Since motorcycles comprise less than one percent of traffic, Harrison (2001) proposed that drivers may not learn the basic avoidance behaviours when confronted by motorcycles at intersections due to a lack of experience in encountering motorcycles during everyday driving. He argued that this lack of experience with motorcycles leads to drivers not learning one or more of the following relationships: (i) a near miss or collision with a motorcycle is a negative event; (ii) when waiting to turn right an oncoming motorcycle is a signal for a negative event; and/or (iii) waiting at an intersection when cued by an oncoming motorcycle can avoid this potential negative event. Harrison (2001) proposed that a training program be developed in which drivers are taught (i) that motorcycles are a signal for impending danger, and (ii) that by displaying avoidance behaviour in the form of giving way that they can avoid a collision with an oncoming motorcycle when turning right at intersections.

Harrison (2002; 2005) developed an avoidance learning intervention in which drivers were presented with photos of on-coming traffic at right-turn intersections and asked to judge whether they would turn in front of the traffic or wait. For the treatment group of drivers, the probability of a crash response was greater when the right turn had to be made in front of an oncoming motorcycle than an oncoming car. For the control group, the probability of a crash was equal for both motorcycles and cars. Both studies showed that participants in the treatment group developed an avoidance response to oncoming motorcycles at intersections (i.e., increased the number of 'wait' compared to 'go' responses) but that the control group did not.

Harrison (2005) found that the effect of the avoidance learning training on drivers' behaviour had not diminished after four weeks, and that the effect only occurred for novice drivers - more experienced drivers were not affected by the training. Harrison explained this difference in learning between drivers with different experience levels by proposing that the prior real-world driving experiences of experienced drivers (where the risk of crashing into a motorcycle is lower than that used in Harrison's experiment) may have overridden any associative learning about an increased risk of crashing in the presence of motorcycles

2.2 ASSOCIATIVE LEARNING AND THE CURRENT STUDY

While Harrison's (2005) research provided evidence that an associative learning intervention could be used to increase drivers' wait responses to on-coming motorcycles at intersections, it was recommended that additional research be conducted before it could be applied in formal training programs. The current study aims to replicate and extend Harrison's (2005) research using several modifications.

A critical question is whether Harrison's (2005) findings can be generalised to real world driving. Decision making when driving occurs in a dynamic environment and Harrison's study used photographs during training and testing. It is possible that the complexity of the driving situation in the real world reduces the influence of higher-order learning processes in favour of low-level perceptual judgements (Harrison, 2005). Therefore, the current study used both digital video footage and photographs as stimuli for the avoidance learning training phase and digital video stimuli only in the testing phases. There are two reasons for including a training condition using photos: (i) effects obtained using dynamic testing stimuli can be directly compared to Harrison's findings that were obtained from static testing stimuli, and (ii) it is important to directly compare the effects of photo and video training stimuli on the strength and longevity of the learnt behaviour. Inclusion of video stimuli will also provide an assessment of whether any learning based on photographic stimuli would extend to situations that more closely resemble real-world driving.

Of further interest to this study is the need to demonstrate transfer of learning from the training environment to the real world. As noted by Harrison (2005), the learning mechanism is strongly dependent on the context in which learning occurs. For example, Harrison's finding of increased caution at intersections when motorcycles are present may not translate to increased caution in other situations in which motorcycles are present. Ideally, a simulator and/or on-road studies that assess the transfer of learning to every day driving contexts would provide an optimum testing environment. However, such an approach was beyond the scope and budget of the current study. Instead, during the testing phases, the current study used additional stimuli to those used in training, where a decision was made for both turning right *out* of the traffic flow *across* the oncoming traffic, and turning right across traffic *into* the traffic flow. This provided an extension of Harrison's study where the training and testing trials only depicted scenarios from the viewpoint of a car turning right out of the traffic flow across oncoming traffic, and may have provided some insight into whether the increased caution found by Harrison would transfer to any situation where a motorcycle is present, or only those identical to the situation in which the training was conducted.

Finally, the current study aimed to evaluate whether the increase in caution when a motorcycle is present is maintained for a period of time that is longer than the four week period used by Harrison (2005). This study included a four week assessment to make direct comparison with Harrison's results, and aimed to conduct testing at twelve weeks post training. Demonstrating that the learning effect could be maintained at 12 weeks would provide better justification for the development of a training program than an effect at four weeks only. However, for reasons that are explained later in this report, the 12-week evaluation was not conducted on the basis of the results of the four-week test.

3 METHOD

3.1 PARTICIPANTS

A total of 111 participants were paid \$45 to compensate for their time and travel expenses, and were recruited from the following groups:

Learner drivers

A total of 32 Learner drivers were recruited from the population of students at Monash University's Clayton and Caulfield campuses and from attendees at an eastern Melbourne Vic Roads licensing office (VicRoads employees were excluded). Participants held a Victorian Learners Permit, and had a mean age of 21.6 years (range = 17 to 27 years).

Probationary drivers

A total of 38 participants with probationary driver licences were recruited from the population of students at Monash University Clayton and Caulfield campuses. The average age of the probationary drivers was 21.1 years (range = 18 to 31 years).

Experienced drivers

A total of 41 participants with full driver licences were recruited from the population of students and staff at Monash University Clayton and Caulfield campuses. The average age of participants was 35.9 years (range = 21 to 69 years).

All participants were allocated into either a static (photo) training condition (n = 63) or a dynamic (video) training condition (n=48), and within these groups, into a learning (treatment) group or a control group.

3.2 PROCEDURE AND STIMULI

Most participants completed the experiment under the supervision of one or more of the authors at the Psychology Computer Laboratories at the Clayton Campus of Monash University. A small number of participants completed the experiment on their own computers at work or home under the supervision of one of the authors. Participants were required to complete the session in one sitting but were given the opportunity for a rest break at the completion of each block of trials.

Upon arrival, participants were asked to read an explanatory statement and sign a consent form. They were then provided more details on the purpose of the study and instructions on how to load and complete the experiment (see Appendix B). The instructions were identical to those used by Harrison (2005) with the exception that one group of participants were instructed regarding how to respond to videos rather than photographs.

The experiment involved repeated exposure to trials in which participants observed digital photographs (if in the Static Group) or digital video footage (if in the Dynamic Group) taken from the position of a vehicle waiting to turn right across the path of oncoming traffic at intersections. Video footage was taken from three different intersections around metropolitan Melbourne using a digital camera mounted on a tripod on the median strip. The experiment had two phases – a learning phase and a testing phase. In both phases, half

the photographs and videos depicted oncoming traffic with a motorcycle present and the remaining showed oncoming traffic without motorcycles.

For the video stimuli used in this experiment, the videos were stopped when the gap between the viewpoint and the approaching motorcycles and/or cars was between 4sec and 5sec. The photographic stimuli were screenshots of the approaching traffic at the same time-intervals between the viewpoint and the approaching traffic as those used for the video stimuli. The above time intervals were chosen because they elicited some uncertainty about whether turning across traffic with these TTCs could have resulted in a crash. Because of the random nature of the feedback (crash or safe) used in the associate learning methodology (see Section 3.3), it would be both confusing to participants and potentially unethical to provide crash feedback for videos of oncoming traffic where it was safe to turn in front of (i.e., relatively large TTCs), or moreover, to provide safe feedback to drivers for turning across traffic that was likely to result in a crash (i.e., relatively brief TTCs).

The participants' task was to make a decision, for each photograph or video, about whether they would turn right across/into the path of the oncoming traffic or give way. They indicated their decision by clicking with a mouse on one of two buttons on the computer screen at the bottom of the photograph or video clip: 'GO' if they decided that they could make the turn safely, or 'WAIT', if they decided that they could not turn safely. Participants had five seconds to make a decision. Figure 1 shows a screenshot of two of the displays in the static photo condition.

In the training phase of the study, participants responded to a total of 200 trials (i.e., videos or photographs) in ten blocks of twenty trials, and the order of presentation of trials was randomised for all participants. Participants completed the testing phase of the study approximately four weeks after completing the training phase. In the testing phase, all participants responded to 100 videos presented randomly in five blocks of 20 trials. That is, while participants were assigned to respond to either photographs or videos of oncoming traffic in the training phase, all participants in the testing phase responded only to videos. Half of the videos used in the testing phase were taken from the point of view of a car driver waiting to turn right at a cross-intersection, and the other half were taken from tee-intersections.



Figure 1. Screenshots of examples of the oncoming car (left panel) and oncoming motorcycle (right panel) displays used in the experiment.

3.3 DESIGN

There was a one second delay period between each trial (video or photograph) in addition to a delay period that varied according to the participant's response. A GO response to stimuli that the computer program had flagged as safe resulted in no additional delay period before the next presentation was shown. During the delay, a grey screen was presented with flashing black text stating 'You turned safely'. A GO response to stimuli that the computer program had flagged as a crash resulted in an additional six second delay during which time a grey screen was presented with the text 'You crashed'. A WAIT response to stimuli resulted in an additional three second delay during which time a grey screen was presented with the text 'You chose to wait'. Finally, no response by a participant resulted in the longest additional delay of eight seconds during which time a grey screen was presented with the text 'No response detected'.

The variable delay periods were incorporated into the experimental design in order to increase the punishment associated with a go response that resulted in a crash, in addition to the negative outcome of a crash. In this task, the negative outcomes, in terms of time delays that affected the total time taken to complete the task, were:

- deciding to WAIT when the software deemed it safe to turn (3 second penalty),
- making an unsafe GO decision when the software determined that a crash would have occurred (six second penalty), and
- not making a decision at all (8 second penalty).

The waiting period for each of these negative outcomes varied in length according to the level of importance attached to training a certain type of behaviour. No delay was given if a GO response was made to stimuli that were flagged as safe, and a longer three second

delay between trials occurred if participants made a ‘Wait’ decision. By coupling the shorter waiting period with the response ‘You turned safely’, and coupling a longer delay period with a wait response, the experiment was designed to bias participants towards making a GO decision as often as possible. Therefore, any increase in wait responses obtained in the study could be attributed to an effect of associative learning.

A six second time delay occurred if participants provided a GO response for a stimulus that was flagged as a crash. Increasing the probability of crash responses for motorcycle stimuli was designed to train participants to be more cautious by avoiding the negative consequence (time delay) that immediately followed the negative event (crash). The longest (eight second) delay was given if participants failed to make a decision, thereby encouraging them to respond to each trial.

The software for the program was designed such that the percentage of crash responses from the computer program for GO decisions in each learning trial was 60% for motorcycles and 20% for other vehicles in the treatment condition, and 40% for motorcycles and 40% for other vehicles in the control condition. That is, the proportion of “crash” responses was higher for motorcycles than cars in the learning group but not for the control group. Therefore, the program was designed to ‘train’ participants to be more likely to give way to motorcycles by increasing the risk of a crash when a motorcycle was present in the oncoming traffic compared to when it was not.

In the testing phase of the study, both the learning group and the control group were exposed to a 60% crash risk for motorcycles and a 20% crash risk for other vehicles. These crash risks replicated those used by Harrison (2005) for the leaning group and control group in his testing phase. The design is summarised in Table 3.2.

Table 1 Experimental Design

	Training Phase	Testing Phase (four weeks later)
Learning Group	Risk of crash with motorcycle 0.6	Risk of crash with motorcycle 0.6
	Risk of crash without motorcycle 0.2	Risk of crash without motorcycle 0.2
Control Group	Risk of crash with motorcycle 0.4	Risk of crash with motorcycle 0.6
	Risk of crash without motorcycle 0.4	Risk of crash without motorcycle 0.2

4 RESULTS

4.1 ANALYSIS TECHNIQUES FOR BINARY DATA

ANOVA and multiple regression models are used when the dependent variable of interest is continuous. They are not appropriate for categorical dependent variables where there are two discrete options such as the option of either a go or wait response (i.e., binary responses). Some researchers attempt to analyse binary data by treating the proportion of subjects who chose a particular response as a continuous outcome of interest, and then using ANOVA or multiple regression methods. A potential problem with this approach is that the model might predict probabilities that do not lie within the valid range of 0 to 1. An alternative approach is to use logistic regression modeling to determine the relationship between predictor variables and a binary outcome variable, by transforming the proportions so that only valid probabilities are predicted (Altman, 1991).

Difficulties in logistic regression analyses arise when observations are not independent, such as when repeated measurements are made from the same participants over time. For continuous outcomes, complex ANOVA models have been developed to analyse data where observations are correlated. For binary outcomes, Generalized Estimating Equations have been developed to allow regression analyses to take into account correlated observations within participants. Given the design of the current experiments, which obtained repeated binary measurements from participants, it was decided that Generalized Estimating Equations would be the most appropriate statistical technique for analyzing the data.

The responses in the current study were coded as go or wait responses; that is, the response data were in binary form. Responses where a time-out occurred were classified as missing data. Generalized Estimating Equations modeled the probability of a wait response as a function of BLOCK (10 blocks of trials in the training phase and 5 blocks in the testing phase), EXPERIENCE (Learner Permit, Probationary License, or Full Driver's License), GROUP (learning, or control), and IMAGE TYPE (motorcycle or other vehicle). Of primary interest to the current study was whether there was a BLOCK x GROUP x IMAGE-TYPE three-way interaction, and/or a significant BLOCK x EXPERIENCE x GROUP x IMAGE-TYPE four-way interaction. That is, the study was primarily concerned about whether the probability of wait responses to motorcycles increased across blocks for the learning group, and whether any increased wait responses varied as a function of the driving experience of participants.

For the analyses of the learning phase, separate analyses were conducted on data obtained from the photograph stimuli and data obtained from the video stimuli. For the analyses of the testing phase, separate analyses were conducted on data obtained from the groups that responded to photographs in the learning phase, and data obtained from the groups that responded to videos in the learning phase.

4.2 LEARNING PHASE

4.2.1 Analysis of learning phase data from photographic stimuli

Table 2. Summary table of results of regression analysis of probabilities of a wait response to photographic stimuli in the learning phase.

	<i>Wald Chi-Square</i>	<i>df</i>	<i>Sig.</i>
(Intercept)	3.040996885	1	0.08119
Block	158.9671534	9	0.00000
Experience	21.91097801	2	0.00002
Group	6.567784689	1	0.01038
ImageType	61.3738131	1	0.00000
Block * Group	28.07565994	9	0.00093
Block * ImageType	88.45645688	9	0.00000
Group * ImageType	13.69911986	1	0.00021
Block * Group * ImageType	39.02524447	9	0.00001
Block * Experience * Group * ImageType	1.0929E+14	59	0.00000

A summary table of the results of the regression analysis of the learning phase with the photographic stimuli is presented in Table 1, and shows that all main effects and interactions were statistically significant. Figure 2 shows the BLOCK x GROUP x IMAGE-TYPE three-way interaction. The probability of a wait response for the control group did not statistically significantly increase over the 10 blocks of trials for photographs of motorcycles relative to that of cars. For the learning group, the proportion of wait responses for photos of approaching motorcycles increased statistically significantly over blocks, and the proportion of wait responses for approaching cars remained relatively constant. While the BLOCK x EXPERIENCE x GROUP x IMAGE-TYPE four-way interaction shown in the Appendix (Figure A1) was also statistically significant, the differences between experience levels did not reflect simple effects of driving experience on the proportion of wait responses that occurred as a function of the significant three-way interaction. That is, the overall increase in wait responses across blocks for the learning group for motorcycle images relative to car images did not vary consistently as a function of driving experience. However, there did appear to be a trend towards the three-way interaction being more pronounced for learner drivers and probationary drivers. The proportion of wait responses for experienced drivers, while higher for motorcycles than that of cars, appeared to increase over blocks for both cars and motorcycles.

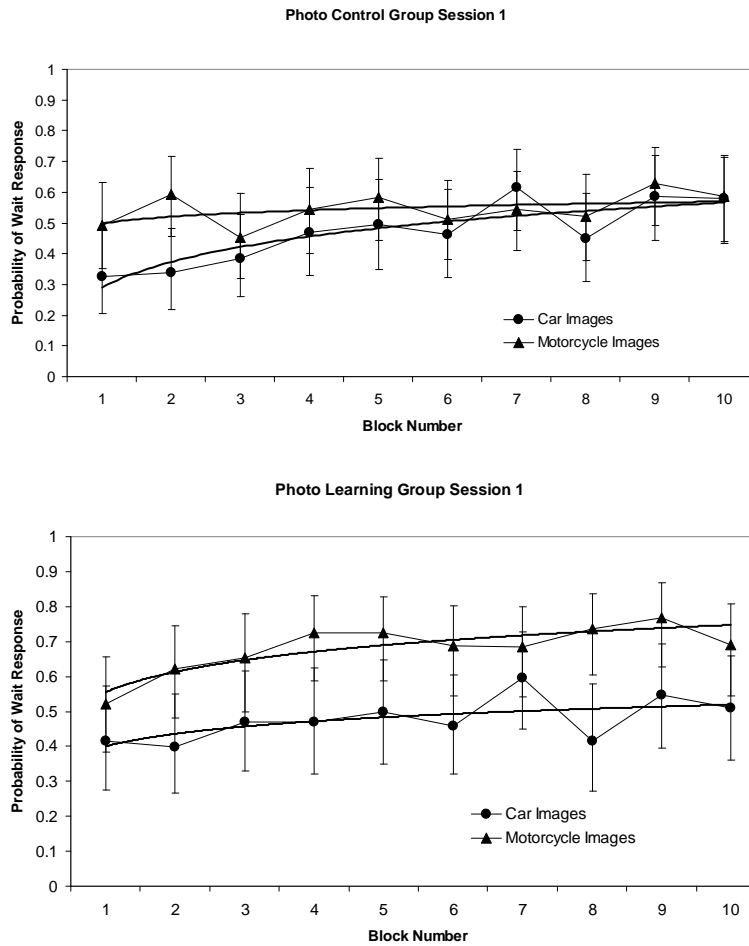


Figure 2. Probability of a wait response to photographic stimuli in the learning phase as a function of block number and image type for the control group (top graph) and learning group (bottom graph).

4.2.2 Analysis of learning phase data from video stimuli

Table 3. Summary table of results of regression analysis of probabilities of a wait response to video stimuli in the learning phase.

	<i>Wald Chi-Square</i>	<i>df</i>	<i>Sig.</i>
(Intercept)	1.661969958	1	0.19734
Block	35.24945346	9	0.00005
Experience	1.972951048	2	0.37289
Group	1.514187927	1	0.21850
ImageType	82.66214365	1	0.00000
Block * Group	20.55321932	9	0.01479
Block * ImageType	14.04172249	9	0.12085
Group * ImageType	1.097572682	1	0.29480
Block * Group * ImageType	24.82271278	9	0.00317
Block * Experience * Group * ImageType	3712.195833	42	0.00000

A summary table of the results of the regression analysis of the learning phase for the video stimuli is presented in Table 2, and shows that there were significant main effects of BLOCK and IMAGE-TYPE, a significant two-way interaction between BLOCK and GROUP, a significant three-way interaction between BLOCK and GROUP and IMAGE-TYPE, and a significant BLOCK x EXPERIENCE x GROUP x IMAGE-TYPE four-way

interaction. Figure 3 shows the BLOCK x GROUP x IMAGE-TYPE three-way interaction. As can be seen in Figure 3, the control group had a larger proportion of wait responses for motorcycles than cars in the second block of trials. However, the proportion of wait responses for approaching motorcycles converged over blocks to be not significantly different than that of cars. For the learning group, the proportion of wait responses to motorcycles did not vary across trials. However, the probability of a wait response to cars decreased over blocks of trials. While the BLOCK x EXPERIENCE x GROUP x IMAGE-TYPE four-way interaction shown in the Appendix (Figure A2) was also statistically significant, the differences in the proportion of wait responses between drivers of different levels of experience were not due to consistent simple effects. There was a trend in the data for drivers at all levels of experience in the learning group to reduce their wait responses to cars. However, while the proportion of wait responses to motorcycles for both the learner drivers and experienced drivers did not appear to change over time, there was a trend in the data for probationary drivers to increase their wait responses to motorcycles.

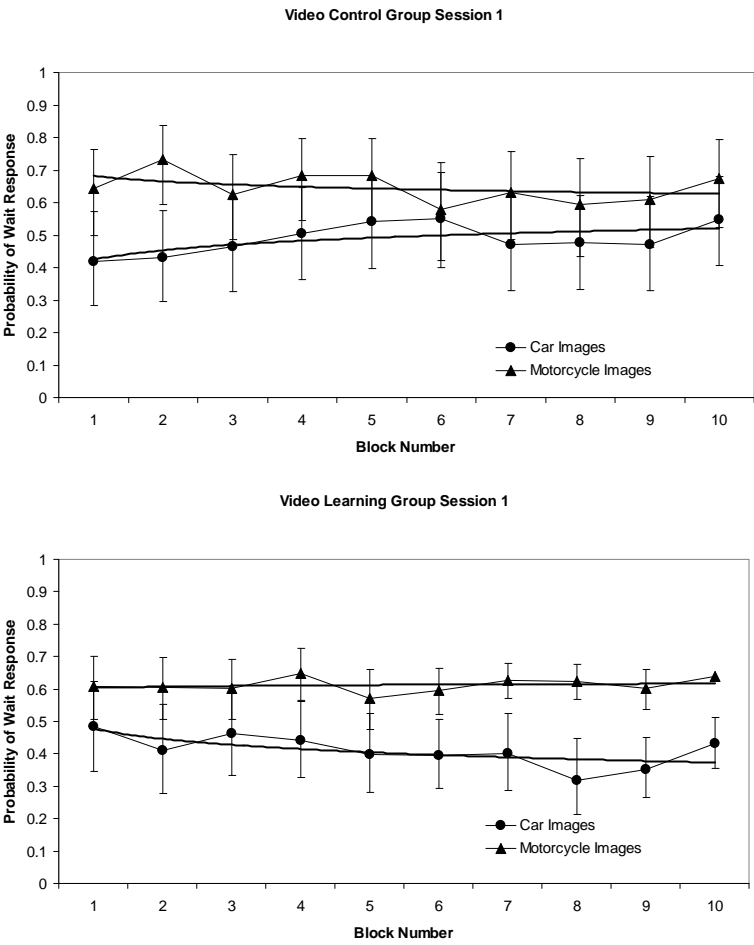


Figure 3. Probability of a wait response to video stimuli in the learning phase as a function of block number and image type for the control group (top graph) and learning group (bottom graph).

4.3 TESTING PHASE

The analysis of the testing phase data, which were all obtained from judgements of video stimuli, was analysed separately for the groups of participants who responded to photograph stimuli in the learning phase of the experiment, and the groups of participants who responded to the video stimuli in the learning phase.

4.3.1 Analysis of testing phase data from video stimuli for the groups that responded to photographs in the learning phase

Table 4. Summary table of results of regression analysis on probabilities of a wait response to video stimuli in the testing phase, for the groups that responded to photographs in the learning phase

	<i>Wald Chi-Square</i>	<i>df</i>	<i>Sig.</i>
(Intercept)	14.3844	1	0.0001
Block	31.2488	4	0.0000
Group	0.1461	1	0.7023
ImageType	38.4887	1	0.0000
Experience	11.1815	2	0.0037
Block * Group	7.1598	4	0.1277
Block * ImageType	9.0366	4	0.0602
Group * ImageType	0.2556	1	0.6132
Block * Group * ImageType	2.8945	4	0.5756
Block * Group * ImageType * Experience	3220.8921	38	0.0000

Table 3 provides a summary table of the results of the regression analysis on the proportion of wait responses to video stimuli in the testing phase, for the groups that responded to photographs in the learning phase. As can be seen in Table 3, there were significant main effects of BLOCK, IMAGE-TYPE, and EXPERIENCE, and a significant BLOCK x GROUP x IMAGE-TYPE x EXPERIENCE four way interaction. None of the remaining main effects or interactions were statistically significant. Figure 4 shows the proportion of wait responses to motorcycles and cars as a function of the significant four-way interaction. The data in Figure 4 indicates that any increases in wait response that were found in the learning phase of the experiment were not transferred to the testing phase. There was a trend for both the control-group and learning-group to have a larger proportion of wait responses to motorcycles relative to cars in the testing phase. However, for the learning group, the proportion of wait responses to motorcycles did not appear to change over time, and the proportion of wait responses to cars appeared to decrease. The interaction of driving experience appears to be due to variations in the slopes of the data such that for some levels of experience the differences in the proportion of wait responses for motorcycles and cars converge, and others remain constant. Overall, the data shows that a statistically significant learning effect, in the form of increased wait responses to motorcycles, did not occur for any level of driving experience.

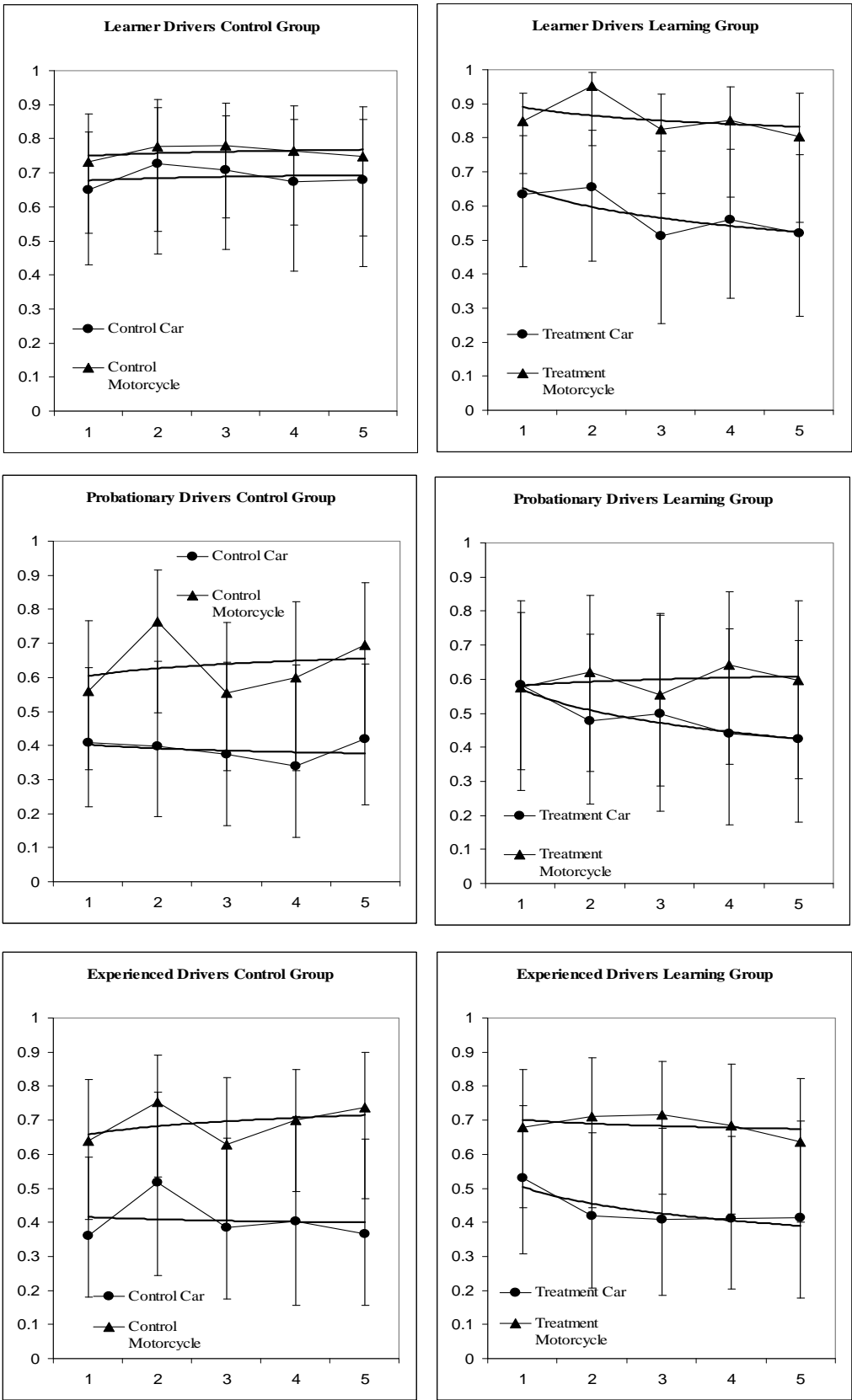


Figure 4. Proportion of wait responses in the testing phase across blocks of trials for motorcycle and car images in the learning and control groups: Learner drivers that responded to photographs in learning phase (top graphs); Probationary drivers that responded to photographs in learning phase (middle graphs); Experienced drivers that responded to photographs in learning phase (bottom graphs).

4.3.2 Analysis of data from video stimuli for the groups that responded to videos in the learning phase

Table 5. Summary table of results of regression analysis of probabilities of a wait response to video stimuli in the testing phase for groups that responded to videos in the learning phase

	<i>Wald Chi-Square</i>	<i>df</i>	<i>Sig.</i>
(Intercept)	0.143	1	0.7058
Block	25.612	4	0.0000
Group	1.446	1	0.2292
ImageType	63.468	1	0.0000
Experience	1.074	2	0.5845
Block * Group	12.349	4	0.0149
Block * ImageType	7.942	4	0.0937
Group * ImageType	0.735	1	0.3913
Block * Group * ImageType	11.157	4	0.0249
Block * Group * ImageType * Experience	16424872.367	38	0.0000

A summary table of the results of the regression analysis on the proportion of wait responses to video stimuli in the testing phase, for the groups that responded to videos in the learning phase, is shown in Table 4. There were significant main effects of BLOCK and IMAGE-TYPE, a significant two-way interaction between BLOCK and GROUP, a significant BLOCK x GROUP x IMAGE-TYPE three-way interaction, and a significant BLOCK x GROUP x IMAGE-TYPE x EXPERIENCE four-way interaction. The significant four-way interaction is shown in Figure 5. The proportion of wait responses to motorcycles and cars were significantly different for experienced drivers in the learning group. As can be seen in Figure 5, experienced drivers in the learning group had a larger proportion of wait responses for motorcycles relative to cars. The data is not consistent between groups, with differences in the proportion of wait responses for motorcycles and cars either (i) converging, (ii) remaining constant, or (iii) diverging.

4.3.3 Analysis of transfer of learning effects to novel intersections

The testing phases used additional video stimuli to those used in training, where a decision had to be made with and without a motorcycle present including turning right *out* of the traffic flow across oncoming traffic in addition to turning right across traffic *into* the traffic flow. This provided an extension of Harrison’s study where the training and testing trials used only photographs from the viewpoint of a car turning right out of the traffic flow *across* the oncoming traffic. However, since the testing phase only used video stimuli, and the analysis of the responses to video stimuli in the learning phase did not find a learning effect, it was decided that a sub-analysis comparing responses to the two different turning contexts was not warranted. In particular, the contextual variation of turning contexts was deemed to have less theoretical importance than the overarching question of why responses to video stimuli did not elicit a learning effect. This question is addressed in the General Discussion.

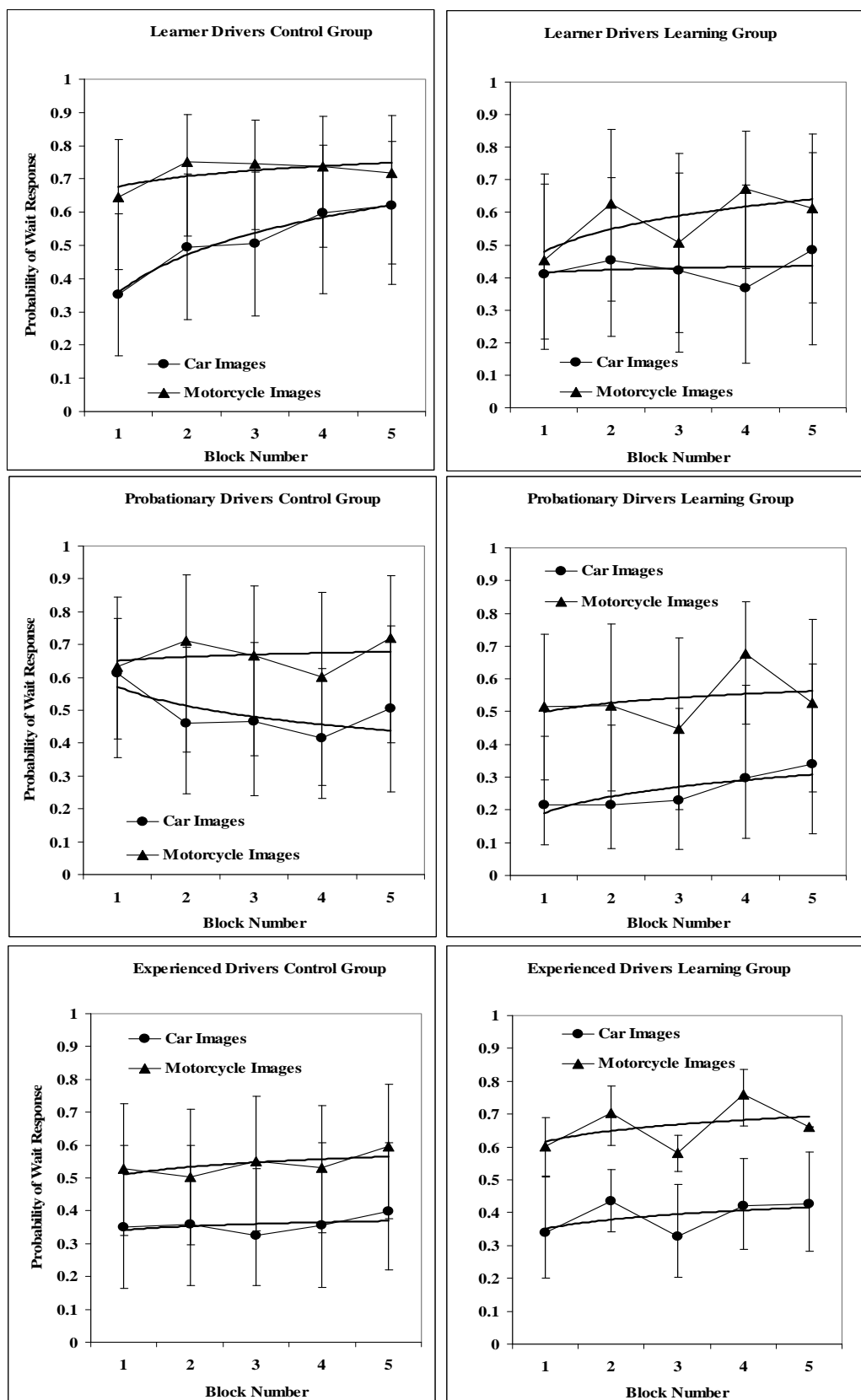


Figure 5. Proportion of wait responses in the testing phase across blocks of trials for motorcycle and car images in the learning and control groups: Learner drivers that responded to videos in learning phase (top graphs); Probationary drivers that responded to videos in learning phase (middle graphs); Experienced drivers that responded to videos in learning phase (bottom graphs).

5 DISCUSSION

The overall results of this experiment are shown in Figures 6 and 7. Figure 6 shows the proportion of wait responses for motorcycle and cars, for the groups that responded to photographs of oncoming traffic in the learning phase of the experiment, and videos in the testing phase. One of the primary aims of the experiment was to replicate the associative learning effect reported by Harrison (2002; 2005). Consistent with Harrison, the results found that a learning effect did occur. As can be seen in Figure 6, participants in the learning group increased their wait responses to motorcycles in the learning phase, while wait responses to cars remained relatively constant. However, a comparison of Figure 6 with Harrison's (2005) Figure 10 (see Figure A3 in Appendix A of this report) indicates that the learning effect in the present study was not as strong as that reported by Harrison (2005). While the present study found that the proportion of wait responses for motorcycles was consistently higher than that of cars, the difference in wait responses was only significantly different in one of the 10 blocks of trials (Block 8). In contrast, Harrison (2005) found that the differences in wait responses for cars and motorcycles in the learning group was significant in four of 10 blocks, and that the increased wait responses for motorcycles were consistent with a learning curve predicted by associative learning.

Also consistent with Harrison (2005) was the finding that participants in the control group (who were not exposed to any increase in crash risk associated with the presence of motorcycles) did not learn to increase their wait responses to motorcycles. While the differences between the proportion of wait responses for motorcycles and cars were not statistically significant for the control group, there was a trend in the data such that the proportion of wait responses found for the control group did not increase over time for motorcycle stimuli, but increased for car stimuli. This had the counterintuitive effect of any initial differences between the proportion of wait responses for motorcycle and car stimuli reducing over time.

An additional aim of this study was to investigate whether the increased wait responses that occurred for the learning group in response to photographs of oncoming motorcycles in the learning phase would transfer to videos of oncoming traffic. A comparison of Figure 6 with the data shown in Harrison's (2005) Figure 10 indicates that the persistence of a learning effect that Harrison found four-weeks after initial learning was not replicated with the video stimuli. The increased wait responses to photographs of oncoming motorcycles found for the learning group in the learning phase of the present experiment did not transfer to the testing phase with video stimuli. In the testing phase, there were no differences between the control and learning groups in the proportion of wait responses for cars and motorcycles, and the proportion of wait responses to motorcycles was not significantly greater than that of cars. Interestingly, there was a trend in the learning group data for the proportion of wait responses to videos of motorcycles in the testing phase to remain constant over time, and for wait responses to decrease over time for videos of cars. This trend in the data was similar to that found for the learning groups that responded to video stimuli in the learning phase, and will be further discussed later in this section.

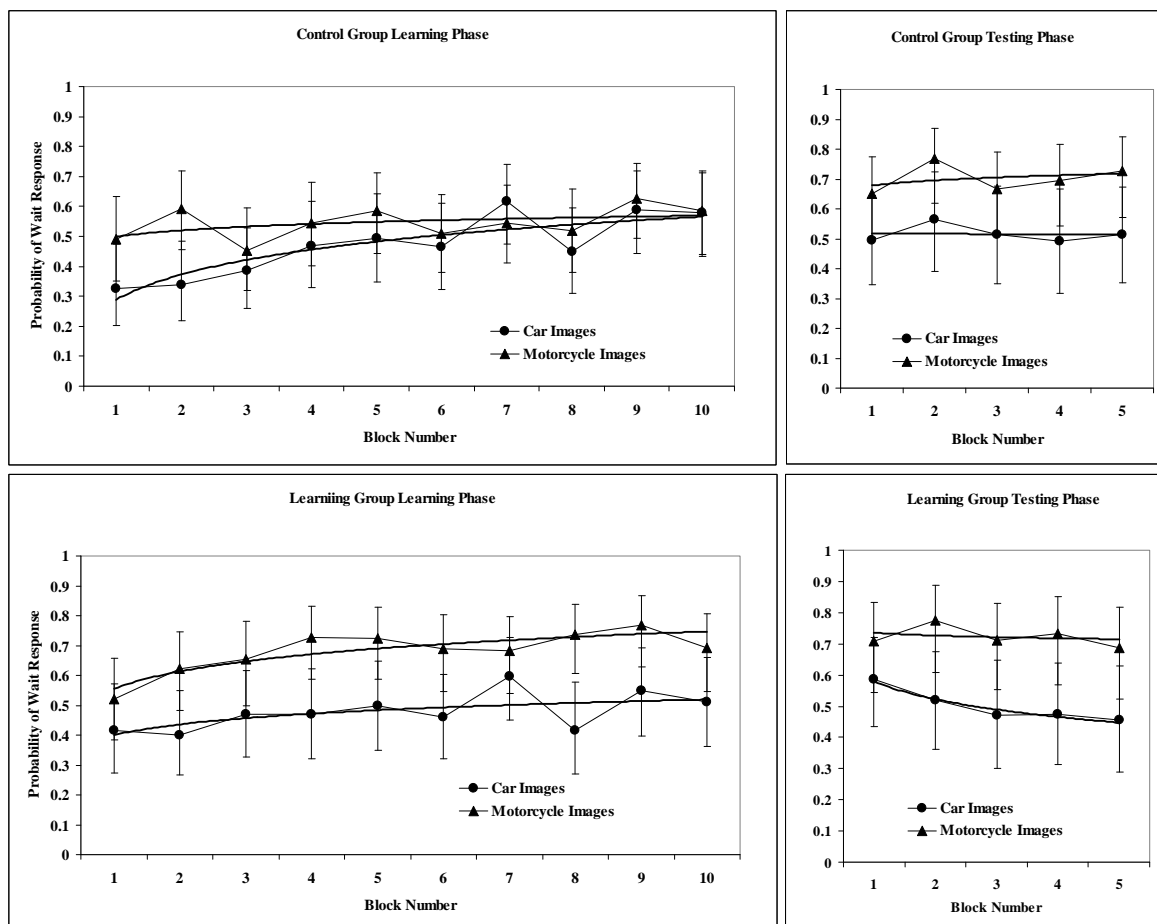


Figure 6. Probability of wait responses for participants exposed to photographs in the learning phase and videos in the testing phase, disaggregated by image type (motorcycles and cars) and group.

A further aim of the present study was to investigate whether the associative learning effect could be replicated when the learning phase consisted of stimuli that more closely resembled the dynamic conditions associated with real-world driving. Figure 7 shows the proportion of wait responses for motorcycle and cars for the control-group and learning-group that responded to videos of oncoming traffic in both the learning phase and testing phase of the experiment. Figure 7 shows that the results obtained from video stimuli in the learning phase were not consistent with the learning effect found for static photo stimuli reported in this experiment, and also by Harrison (2002; 2005). These results indicate that increased wait responses to motorcycles could not be replicated for scenarios that more closely replicated the dynamic contexts of real-world driving.

In contrast to the static photo stimuli, it does not appear that the proportion of wait responses for videos of approaching motorcycles increased over time for the learning group. Rather, inspection of Figure 7 shows that the proportion of wait responses to videos of approaching cars decreased. The significant reduction in wait responses to videos of cars was an interesting result that demonstrated an unexpected effect of the experimental manipulation of crash risk. It appears that having a low crash risk associated with cars for the learning group and a higher crash risk for motorcycles led to changes in responses that were only consistent with the lower crash risk associated with cars. It is particularly noteworthy that the associative learning intervention had a larger effect on reducing wait responses to videos of cars (i.e., significant differences in the proportion of wait responses

between motorcycles and cars in blocks 6-10) than on increasing wait responses for the photographs of motorcycles (i.e., significant differences between motorcycles and cars in block 8 only). Furthermore, Figure 7 shows that the significant decrease in wait responses to cars was maintained in the four-week follow up test. Such an inhibitory learning effect is problematic for the associative learning approach as a decrease in wait responses to cars could lead to an increased risk of crashes involving approaching cars if the effect transferred to real-world driving. Further investigation of associative learning interventions for changing driving behaviour would need to explore more appropriate manipulations of crash risks associated with oncoming cars before such an approach could be formally applied to driver training.

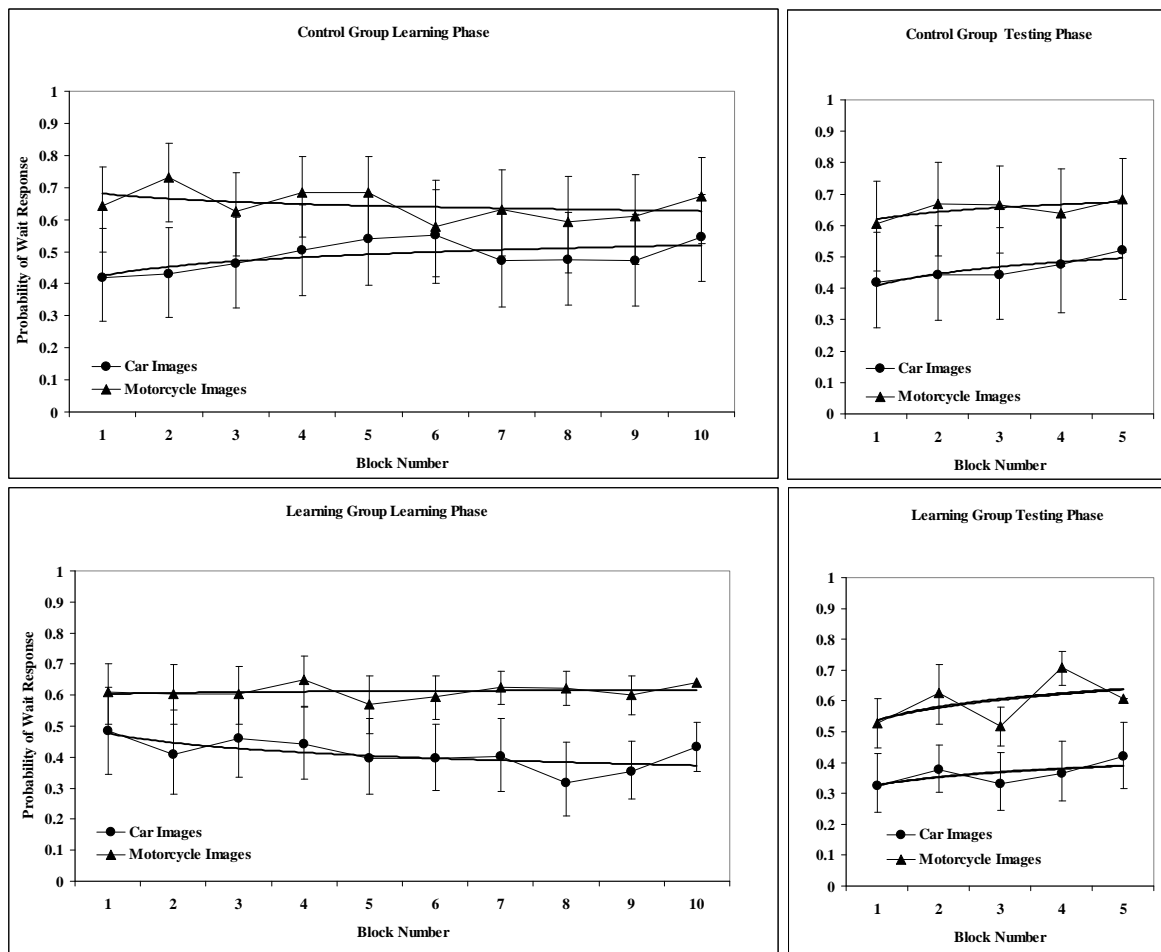


Figure 7. Probability of wait responses for participants exposed to videos in both the learning and testing phase, disaggregated by image type (motorcycles and cars) and group.

In summary, the present study replicated Harrison's (2002; 2005) findings that an associative learning intervention increases the likelihood of drivers to respond that they would wait for approaching motorcycles at intersections. However, such learned avoidance responses only occurred when the associative learning intervention used photographic stimuli, and the increase in learned wait responses that occurred for photographic stimuli in the initial phase of the experiment was extinguished in a follow-up test using video stimuli. When the intervention used video stimuli, there was no evidence of increased avoidance responses to motorcycles. Rather, the probability of a wait response to cars decreased in a

manner that was consistent with inhibitory learning, and this latter effect persisted in a four-week follow up test.

Overall, the results found that associative learning effects do not appear to occur in dynamic contexts where the task is more representative of real-world driving. Furthermore, the study was unable to demonstrate transfer of avoidance learning from the static learning contexts to dynamic contexts that more closely simulated the environments in which judgements are made when turning at intersections. It is important to note that the present study used a methodology that was highly similar to that used by Harrison (2005). Therefore, it cannot be argued that the conflicting findings were due to different characteristics of participants, or because of procedural differences between the two studies. The only substantial difference between the present study and that conducted by Harrison (2005) was the inclusion of video stimuli. Hence, the failure of the associative learning intervention to increase wait responses to videos of approaching motorcycles at intersections appears to be associated with factors associated with the use of video stimuli. In light of these findings, it was recommended not to proceed with a 12-week test to investigate the longevity of associative learning in dynamic contexts. VicRoads commissioned MUARC to conduct an alternative task that involved making conclusions and recommendations about the associative learning technique, and other methodologies, for training drivers to give way to motorcycle riders at intersections. The revised task was designed to provide some explanation for why the associative learning intervention was unsuccessful for the video stimuli, and provide suggestions for future experiments. The results of this task are presented in the following section.

6 GENERAL DISCUSSION

This study found that drivers' increased wait responses to photographs of approaching motorcycles at intersections produced by associative learning could not be replicated with video-based training for both the initial learning phase of the experiment and the following test phase. This section will review the literature that suggests that driving behaviour can be modelled on associative learning principles, and will use this review to comment on whether it is logical to suggest that such learning could be used for training drivers to give way to motorcycles at intersections. The report provides a critique of the associative learning approach and its limitations in order to understand why the video based training did not produce a learning effect similar to that reported by Harrison (2005) using static images. Given that the role of associative learning in training drivers to avoid collisions with motorcycles has been reported in three previous reports (Harrison, 2001; 2002; 2005), this section also provides a summary of these reports in order to provide an overview of the methodologies that were used and the reported results. Alternative training methodologies that could potentially be used to train drivers to avoid crashes with motorcycles at intersections are then reviewed. The section concludes with proposed experiments based on the above analysis, including suggestions for further investigations of the associative learning method, and a new method based on an alternative approach to the determinants of intersection crashes.

6.1 ASSOCIATIVE LEARNING AND DRIVING BEHAVIOUR

Associative learning is a well-established principle of behaviour that describes a learning process in which a new response becomes associated with a particular stimulus. Such learning takes place because of learned contingencies (relationships) between two events where if a first event occurs, then there is a higher chance of a second event occurring (Harrison, 2001). Stronger learning effects occur when the second event (a reward or punishment) has an element of randomness. Parsons (1976) and Fuller (1984; 1988; 1992) have suggested that associative learning processes can be used to model driving behaviour. Fuller (1984; 1988) provided a theoretical argument that driving behaviour is determined by learned associations between a driving action in response to objects (stimuli) in the road environment, and its consequences. He argued that all stimuli in the driving environment (e.g., other vehicles, pedestrians, road features, and obstacles) have the potential to be aversive to the driver, depending on the interaction between the driver's behaviour and the properties of the stimuli. Given the potential for a stimulus to be aversive, the actions of the driver depend on the contingent rewards and punishments that have been learned directly from prior exposure to outcomes of alternative behaviours.

Interestingly, Castallà and Pérez (2004) have found that there is a relationship between drivers' sensitivity to reward and punishment and driving behaviour such that drivers with high sensitivity to punishment and low sensitivity to reward are less likely to commit traffic violations than those with low sensitivity to punishment and high sensitivity to reward. In driving contexts, the rewards of unsafe driving behaviour (e.g., exceeding the speed limit, or running red lights) might be reaching a destination faster, or higher levels of sensation (i.e., avoiding monotony). Punishments might be crashes, near misses, monetary fines and demerit points.

The associative learning model of driving behaviour was further explored by Harrison (2001; 2002; 2005), and led to his proposal that an associative learning paradigm may be a useful approach to changing drivers' responses to motorcyclists at intersections.

Specifically, Harrison proposed that drivers could learn new (and potentially safer) responses to oncoming motorcycles when turning at intersections, and that this new learned behaviour could possibly be extended to real-world driving. For the current study, and those reported by Harrison (2002; 2005), the contingencies to be learned were the presence of a motorcycle and crash risk. It was predicted that by increasing the crash risk associated with the presence of a motorcycle, participants in the computer based tasks would learn to be more likely to indicate that they would give way to motorcycles at intersections.

One of the reasons that Harrison (2001) recommended exploration of the associative learning approach was because it could be used to make predictions about intersection crashes involving motorcycles that were consistent with crash data. An associative learning model of driving behaviour predicts that avoidance responses by drivers (such as giving way to a motorcycle at an intersection) are reinforced by feedback. However, the implication of this on driving safety is that incorrect responses may occur if the event is rarely experienced, or when an avoidance response was unnecessary (e.g., when a safe turn at an intersection with an approaching motorcycle does not result in a collision). On this basis, it would be predicted that both learner-drivers and experienced-drivers may not give way to motorcycles because learner drivers may have no or minimal experience interacting with motorcycles at intersections, and experienced drivers may have had many such interactions that have not led to an aversive outcome. The above experiences (or lack thereof) of drivers may occur due to low exposure to motorcycles (that constitute a relatively small proportion of the fleet of vehicles), or the forgiving nature of the road system, in particular where the error of the driver is compensated for by the collision avoidance actions of a motorcycle rider. It has been claimed that the drivers' experience interacting with motorcyclists results in car drivers not attending to motorcyclists because they have conditioned themselves to only look for other cars as possible collision dangers (Mannering & Grodsky, 1995). The aim of the associative learning intervention used by Harrison (2002; 2005) was to change responses to motorcycles (based on prior associations) by increasing the crash risk associated with motorcycles.

Harrison (2001) analysed the Victorian crash database to investigate whether crash rates for drivers involving motorcycles at intersections increased with driving experience, which was presumed to be because of a low exposure to such interactions. He found support for a predicted link between driving experience and intersection crashes occurring. Consistent with the associative learning approach, the results of Harrison's (2001) analysis found that, (i) there was a positive relationship between the proportion of intersection crashes involving motorcycles and the age of the driver, (ii) age-related reductions in crash risk were smaller for crashes involving motorcycles than those involving other vehicles, and (iii) the difference between age-related reductions in crash risk increased with age and were greatest for situations where conflicts with motorcycles were less common. Harrison (2001) recommended that further formal tests of the associative learning model be undertaken in order to evaluate its effectiveness for countermeasure development.

6.2 RECOMMENDATIONS FOR DRIVER TRAINING BASED ON ASSOCIATIVE LEARNING.

The theory that driving behaviour can be modelled on associative learning has led to recommendations on how it could be used to train drivers using countermeasures that manipulate the contingencies between driving responses and their outcomes. For example, Fuller (1984; 1988; 1990) recommended that avoidance behaviour be made more

rewarding through training, and that the negative outcomes of non-avoidance behaviour be facilitated through driver education. In addition both Parsons (1976) and Fuller (1984) recommended that strategic use of signs indicating the potential for stimuli associated with negative outcomes could motivate the driver to be more likely to display avoidance behaviours. Harrison (2001) also made recommendations based on the associative learning model that were specific to addressing intersection crashes involving motorcycles. Harrison proposed that computer-based training could be used to change drivers' turning responses at intersections by increasing the crash risk associated with motorcycles. He argued that such training should change turning behaviour such that drivers would be more likely to give way to oncoming motorcycles at intersections.

Following Harrison's (2001) conclusion that associative learning processes can be used to model driving behaviour, and that multi-media-based interventions could be used to manipulate the contingencies experienced by drivers, Harrison (2002) provided a logical analysis of why intersection crashes, where drivers' fail to give way to oncoming motorcycles when turning at intersections, could be explained by associative learning processes. Harrison (2002) subsequently conducted two experiments that investigated the use of an associative learning approach for training drivers to avoid collisions with motorcycles at intersections. The first experiment had two phases, of which one incorporated the recommendations of Fuller (1984) and Parsons (1976) that signs could be used to invoke avoidance behaviour. Both experiments were carried out using photographs of approaching traffic from the viewpoint of a car driver at an intersection. Participants were required to respond whether they would turn right across the path of the oncoming traffic or if they would wait (i.e., whether they would "go" or "wait"). The first phase involved drivers learning about a relationship between the presence of a motorcycle in oncoming traffic and an increased risk of crashing when turning across the oncoming stream of traffic. The second phase involved drivers learning about a relationship between the presence of a new motorcycle warning sign and the presence of a motorcycle in the oncoming traffic. Harrison manipulated the contingencies between the participants' responses and crash risk by manipulating the feedback to drivers if they decided that they would turn. That is, if drivers responded that they would turn, the probability of receiving feedback that they would have crashed was higher if a motorcycle, and/or a motorcycle warning sign, was present. The aim of the experiment was to investigate whether these manipulations increased the probability of a wait response for motorcycles and/or motorcycle warning signs. Harrison (2002) predicted that if drivers could learn the relationship between the presence of motorcycles and increased crash risk, then drivers would be less likely to indicate that they would turn across oncoming motorcycles "*under conditions of uncertainty*" when a warning sign was present. These conditions of uncertainty are noted for further consideration when we review alternative training methodologies later in this report, and will be described below.

The photographs of oncoming traffic used in Harrison's (2002) first experiment were taken at a range of distances from the viewpoint (camera). The feedback given to drivers about whether a go response resulted in a crash varied depending on the distance of the vehicles, and whether a motorcycle was present in a photograph. That is, there was a higher chance of crash response if a motorcycle and/or motorcycle warning sign was present only if the distance of the approaching motorcycle was relatively close. For greater distances, the chance of a crash response decreased, but was always higher for motorcycles than for cars. Harrison used photographs of oncoming traffic at different distances in order to replicate the range of distances experienced when turning at real-world intersections, and manipulated the relationship between distance and crash response because it reflected the likelihood of crashes in real world driving. That is, a crash is more likely to occur if a

driver turns across traffic that is relatively close (i.e., has a relatively brief time-to-collision), than when the approaching traffic is relatively far (i.e., has a relatively long time-to-collision). In these terms, the conditions of uncertainty used by Harrison can be defined as distances of oncoming traffic, where it would be uncertain whether a decision to turn would result in a crash.

The results of Harrison's (2002) first experiment did not find that the associative learning intervention had an effect on participants' responses. That is, the manipulation of crash risk associated with the presence of a motorcycle in the photographs did not increase the cautionary behaviour of participants (i.e., training did not increase wait responses nor decrease go responses). Overall, an associative learning effect did not occur (i) when judging whether to turn across oncoming motorcycles at intersections, (ii) when judging whether to turn at an intersection when a motorcycle warning sign was present, or (iii) for oncoming traffic at any distance from the viewpoint.

The second experiment conducted by Harrison (2002) investigated whether the absence of associative learning in his first experiment was due to participants in that study having to learn two contingencies – one contingency between the presence of an approaching motorcycle and increased crash risk, and a second contingency between the distance of the vehicles and the risk of the crash. He argued that prior learning of this latter contingency (i.e., that closer oncoming traffic is more likely to lead to a crash outcome than farther oncoming traffic) may have overridden learning about the contingency between the presence of motorcycles and increased crash risk. Harrison addressed this possibility by only having a single learning phase that consisted of learning the relationship between the presence of a motorcycle and increased crash risk, and only presenting photographs of oncoming traffic under conditions of uncertainty. That is, the risk of a crash was not contingent on the distance of the approaching vehicle; rather, crash risk was only contingent on the presence or absence of a motorcycle.

The results of the second experiment found that increases in wait responses¹ occurred only for the learning group and only for responses to photographs of oncoming motorcycles. On the bases of these results, Harrison (2002) concluded that (i) the failure to facilitate associative learning in the first experiment was due to the inclusion of the contingency between the distance of the approaching vehicles and crash risk, and moreover, (ii) that associative learning mechanisms can act to increase drivers' wait responses to motorcycles at intersections.

A third experiment conducted by Harrison (2005) was a partial replication and extension of his previous experiments that aimed to investigate whether the associative learning effect was: (i) robust (i.e., could be replicated), (ii) varied as a function of the driving experience of participants, and (iii) would be replicated in a follow-up assessment held four weeks after the learning trials². Three groups of drivers (learners, probationary, and fully

¹ While Harrison (2002, 2005) also reports decreases in go responses that occur due to associative learning mechanisms, the magnitude of these decreases are approximately inversely proportional to the reported increases in wait responses. In order to maintain clarity in the General Discussion, only the effect of associative learning on increasing wait responses are reported.

² While Harrison (2005) also aimed to investigate whether the responses of the control group in the follow up study were influenced by their exposure to contingencies in the learning trials, this aim is not of direct relevance to the critique presented in this General Discussion.

licensed) were required to make a go or wait response to photographs of oncoming traffic and the risk of a crash for go responses was higher for motorcycles than cars. The results were consistent with an associative learning model of intersection behaviour, and therefore suggested that the effect of associative learning on increasing wait responses to oncoming motorcycles was robust. Harrison (2005) also found that the learning effect had not extinguished at the four-week follow-up session. Interestingly, the effect of associative learning on wait responses only occurred for participants with relatively low driving experience (learner and probationary drivers). There were no significant increases in wait responses for drivers with a full driver's license. Harrison suggested that the absence of an associative learning effect for the full licensed drivers was due to their prior exposure to real-world driving where they would have learned that, all other factors being equal, the risk of crashing is low, and that the risk of crashing when turning in front of motorcycles is no greater than that when turning in front of cars.

Harrison (2005) concluded with a recommendation to undertake further research before adopting a formal associative learning driver training program. He recommended that because decisions about whether to turn at real-world intersections are made in dynamic environments, the effects of associative learning on driving behaviour should be investigated in dynamic contexts such as measuring responses to videos of oncoming traffic, or in a driving simulator. This recommendation was accepted by VicRoads and an investigation was undertaken in this report.

The experiment reported in the present study used the same method as in Harrison (2005) except that participants were required to respond to either photographs or videos. The results of this experiment showed that the associative learning effect reported by Harrison was replicated for the photographic stimuli – the proportion of wait responses for oncoming motorcycles increased for the group of participants exposed to increased crash risk for motorcycles. Interestingly, there was no interaction between driving experience and the probability of a wait response, indicating that the effect occurred irrespective of the experience of the participant. However, the associative learning effect was not replicated for the video stimuli. The probability of a wait response for videos of oncoming motorcycles did not increase, but rather, the probability of a wait response decreased for oncoming cars. In a follow-up session four weeks later, all participants were required to respond to video stimuli, and the results did not find an increase in wait responses due to associative learning.

6.3 EXPLANATIONS FOR WHY ASSOCIATIVE LEARNING DOES NOT INFLUENCE JUDGEMENTS OF VIDEOS OF MOTORCYCLES AT INTERSECTIONS

The following provides a possible explanation for why the results of the video based training did not replicate the results reported by Harrison. One of the core principles of the associative learning approach is that psychological theories can be characterised fully in terms of observables (stimulus and response), without any reference to intervening higher-order processing. This principle has been criticized by many researchers in psychology, and it is now widely accepted that associative learning theories are unable to explain many complexities of human behaviour (Gardner, 1985). Furthermore, in every other domain of science (from physics, to chemistry and biology), theorists frequently postulate intervening, unobservable constructs, and the domain of psychology should be no different in that respect. A dominant approach in psychology today is the “information processing” paradigm, in which theories invoke higher-order processes that are related to perception,

attention, and memory. These theories offer a more complex understanding of behaviour, rather than one based on a single link between stimulus and response.

The above critique of associative learning can be used to explain why the video-based training did not produce an increase in wait responses to motorcycles. That is, modelling driver behaviour in terms of associative learning does not account for the complex information processing that is necessary for a driver to make an appropriate response in driving environments. Associative learning attempts to train/develop a link between a stimulus and a desired response. Taking the information processing approach, driving tasks are more complex. Therefore, the more dynamic and realistic the training stimuli become, the greater the information processing demands/requirements, and the greater the likelihood that the stimulus-response relationship will be confounded by broader perceptual and cognitive demands.

With respect to turning at intersections with approaching motorcycles, a decision to proceed is based not only on the presence of the motorcycle (and possibly the learned contingencies between motorcycles and crash risk), but also on the driver's perception of the distance and *speed* of motorcycle. In particular, the driver must base a decision to turn on information about the amount of time available to turn without colliding with the approaching motorcycle. This amount of time is termed time-to-collision (TTC), and the TTC of an approaching vehicle varies as a function of its distance and its speed (velocity). In these terms, successful driving behaviour when turning at an intersection (i.e., turning behaviour that does not result in a crash or near-miss) depends on accurate perceptual judgements of TTC. Indeed, Harrison (2005) noted that "It might be argued that the complexity of the driving situation in the real world reduces the influence of basic learning processes in favour of higher-order processes [perceptual processes]". Indeed, the plausibility of this claim is demonstrated by the influence of perceptual processes in Harrison's (2002) first experiment, where participants' perception of distance appeared to override the learning of a relationship between stimulus (motorcycle) and crash risk.

For the video stimuli used in this experiment, the videos were stopped when the TTCs of the approaching motorcycles and cars were between 4sec and 5sec. These TTC values were similar to the conditions of uncertainty used by Harrison (2002; 2005). That is, the TTCs of approaching traffic of between 4 to 5 secs were chosen because they elicited some uncertainty about whether turning across traffic with these TTCs could have resulted in a crash.

When participants were presented with photos of oncoming vehicles at distances defined as conditions of uncertainty, information about the speeds of the vehicles was not available. Under these conditions, randomly assigning feedback about whether the participant would have crashed could have influenced participants' responses because the information in the photograph was incomplete (i.e., it only provided information about distance and not speed); therefore, the task did not produce (or at least minimised) a conflict between information from perceptual processing and feedback. Or in other words, because of the relatively low levels of information available for judgements relating to TTC available from static images, the information processing demands on the participant are low, and thus the potential for a stimulus-response relationship to develop is greater. However, in the dynamic stimuli, participants did have access to information about the approach speed of the vehicle and there may have been a conflict between perceptual processing of information about the TTC of the vehicles and the feedback given to participants. Such potential conflict has also been noted by Harrison (2005) in that the dynamic sources of perceptual information in real-world driving may override any contingencies learned in

simulated contexts. This potential conflict is likely to have influenced participants responses and led to the absence of an beneficial effect of associative learning because of (i) an overriding reliance on perceptual processing (where wait responses to motorcycles did not change on the basis of feedback), or (ii) a negative effect of associative learning (where wait responses to cars decreased with feedback).

The implication from the above results on the associative learning approach to driving behaviour is that learned wait responses to motorcycles may be extinguished as soon as the driver is exposed to the complexities of real-world driving where both the behaviour of the motorcycle (e.g., its TTC), the behaviour of other vehicles, environmental conditions, and the drivers' own level of skill, need to be taken into account. That is, while a simple wait response to any approaching motorcycle is a safe response, in some circumstances (e.g., when the motorcycle is relatively far away in time/space) a simple wait response is not necessary for safe turning behaviour. Such discrepancies between responses learned in the laboratory and drivers' real-world perceptual experiences are likely to have a strong impact on the efficacy of training programs that are based on the associative learning model.

6.4 POSSIBLE FURTHER INVESTIGATION OF ASSOCIATIVE LEARNING FOR REDUCING INTERSECTION CRASHES INVOLVING MOTORCYCLES

It has been proposed in this report, and acknowledged by Harrison (2005), that increased safe responses that have been learned for static photographs of oncoming motorcycles may not be transferable to real-world driving contexts. We have made this claim on the basis of an experiment which used the associative learning method in dynamic contexts that more closely represented real-world conditions, and a logical analysis of the factors involved in real-world crashes with motorcycles. However, it was noted that the simulated task used to test associative learning in dynamic contexts used feedback that conflicted with the information available in the video stimuli.

Harrison (2002) has argued that learned responses for static stimuli may not extinguish in real-world settings because wait responses to oncoming motorcycles at intersections will be rewarded with safe consequences. While we have argued against this claim, it is yet to be tested whether the increased wait responses learned in the photo task can be transferred to actual driving behaviour where the only feedback available to the driver is a successful turn, a near miss, or a crash. Therefore, the associative learning approach cannot be falsified until an evaluation is carried out of whether increased wait responses to photographs of motorcycles can be transferred to settings that approach real-world driving. Such an evaluation could be accomplished by replicating the associative learning effect for photograph stimuli, and then having participants make actual turns at intersections where the gap between the driver and oncoming traffic, including motorcycles, is varied. If the responses learned in the first phase are transferable, then participants should make safe turning responses. This prediction could be tested using the MUARC advanced driving simulator.

In summary, the associative learning paradigm cannot be ruled out as an appropriate intervention for training drivers to give way to motorcycles at intersections until further investigations of whether learned avoidance responses to photographic stimuli is carried out. What is being ruled out is the use of dynamic images during the training phase, as dynamic images have been shown to have no effect on improved wait decisions (and thus the development of the stimulus-response relationship). Rather, it is proposed that the

associative learning paradigm be re-examined, retaining the use of static images during the training (as per Harrison, 2005) but using a more real-world setting for the evaluation; namely, evaluating the associative learning methodology using a driving simulator to measure actual turning behaviour rather than PC-based go/wait responses.

6.5 ALTERNATIVE APPROACHES TO TRAINING DRIVERS TO CORRECTLY JUDGE WHETHER TO TURN AT INTERSECTIONS WITH MOTORCYCLES

A recent study by Clarke et al. (2007) has investigated intersection crashes involving motorcycles in the UK. They found that the majority of these crashes (81%) were the fault of the drivers of other vehicles. These findings were consistent with previous studies that have shown that the majority of intersection crashes involving motorcycles occur when drivers fail to give way (e.g., Hurt et al., 1981; Lynam et al., 2001; Sexton et al., 2004). Moreover, over 65% of intersection crashes involving motorcycle riders where a car driver was to blame occurred because the driver reported that they did not see the motorcycle, even when it should have been in view. Clarke et al. also found that, similar to the Victorian crash statistics reported by Harrison (2001), the average age of drivers that were at fault in intersection crashes involving motorcycle riders was that of an experienced driver, and that the proportion of crashes involving a driver failing to see the motorcycle rider increased with age. It is also noteworthy that 30% of intersection crashes where the driver was at fault occurred even when the motorcyclists used visibility aids such as daytime running lights, and/or reflective clothing.

Rather than explain the above crash statistics in terms of associative learning, Clarke et al. proposed that intersection crashes involving motorcycles occur because drivers fail to see the motorcycle. These types of crashes have been explained in terms of the 'looked but did not see' (LBDNS) phenomenon, and are proposed to be based on inadequate higher-order (attentional) processing. Clarke et al (2007) proposed that possible explanations for LBDNS crashes can be explained by either: (i) drivers' attention being directed to features of the traffic environment that their experience has shown to be of critical importance, but which inhibits attention to other objects (e.g., motorcycles; c.f., Duncan, 1996), (ii) drivers only attending to proximal (near) objects, and missing the approach of more distant but rapidly approaching vehicles such as motorcycles (c.f., Treisman, 1996), or (iii) drivers being less likely to detect a motorcycle when looking directly at it, rather than if it is located in the periphery (i.e., attentional blindness; c.f., Mack & Rock, 1998). However, it has been suggested that basing crashes on the LBDNS phenomenon and associated attentional processes is controversial and requires further investigation before being accepted as a determinant of driving behaviour (Brown, 2002). One criticism of this approach is that the crashes that are reported to be due to LBDNS are based on subjective reports from the drivers. The problem with relying on such subjective reports include the fact that there could be legal implications of drivers' admitting that crashes were due to other errors (e.g., incorrect perception of a gap in traffic, or reckless turning behaviour) and therefore they may be less likely to report that they were to blame due to their own driving error, and that subjective reports can differ greatly from what actually occurred (i.e., drivers' memory of the factors involved in a crash may be distorted, and/or drivers may simply be unaware of what factors contributed to the crash).

An alternative explanation for what have been described as LBDNS-based crashes is that there was a failure of visual processing on the part of the driver. That is, crashes that occur when a driver turns in front of an oncoming vehicle could include a failure of the driver to

visually scan the environment sufficiently well for detection of motorcycles (in particular when there is a restricted view of the motorcycle) or failures to correctly judge the distance and or speed of the approaching motorcycle. In the next section, we will argue that these factors (i.e., factors based on visual processing) may be more correctable with driver training than LBDNS errors that may be based on failures of drivers' attention. Before doing so, the following provides a brief review of evidence that suggests that visual processing errors are a major contributor to crashes involving misperceptions of gaps in traffic.

Recent research suggests that drivers overestimate gaps for oncoming motorcycles relative to larger vehicles (Caird & Hancock, 1994; Horswill et al., 2005). On this basis, it is possible that an alternative explanation for why intersection crashes with motorcycles occur is that drivers overestimate the amount of time until an approaching motorcycle would reach them, and therefore overestimate the amount of time that they have to avoid a collision with a motorcycle when turning at an intersection. Interestingly, it has been shown that older drivers are less able to judge gaps in traffic than younger drivers (see Mather, 2007). This suggests that the over-involvement of older drivers in intersection crashes with motorcycles reported by Harrison (2001) and Clarke et al. (2007) could be the result of perceptual errors rather than associative learning.

A long established and widely accepted explanation for why this misperception of gap occurs for oncoming motorcycles is that drivers judgements of the amount of time until an approaching object will reach them (i.e., TTC judgements) are influenced by cues that are not reliable. Namely, TTC judgements are based on the size of the approaching object such that smaller objects are underestimated relative to larger objects (e.g., DeLucia, 1991; DeLucia et al., 2003). This underestimation of the TTC of smaller objects has been shown to be due to observers' reliance on optic cues (the optic expansion rates of approaching objects (Smith et al., 2001; Caird & Hancock, 1994) that are not reliable determinants of TTC because they vary as a function of object size.

A critical point here is that TTC judgements can be trained, with feedback, to be more accurate (Smith et al., 2001). This suggests that if intersection crashes involving motorcycles are the result of drivers incorrectly judging TTC, then such crashes could be reduced if drivers were trained to judge the TTC of motorcycles accurately. This perceptual learning approach to intersection crashes involving motorcycles may provide a viable alternative to the associative learning approach. Gibson (1961) stated that it is necessary to train individuals in their ability to discriminate, and to educate their attention, and the following proposal can be used as an experimental design for training drivers to accurately attend to, and discriminate, the TTC of approaching motorcycles.

6.6 EXPERIMENTAL DESIGN FOR TRAINING DRIVERS TO ACCURATELY JUDGE THE TTC OF MOTORCYCLES

Interventions based on perceptual learning of TTC judgements have been reported to be successful for training pedestrians to accurately judge gaps in traffic when crossing roads (Young & Lese, 1987; Thompson et al., 2005). Of most interest to the present proposal is that Thomson et al. (2005) used computer simulations to train pedestrians to cross approaching traffic when there were sufficient gaps in traffic. The results found that this training led to more accurate gap selection, and also that the pedestrians were less hesitant in making their responses (which is an important finding in the context of road crossing where decisions are time-critical). Moreover, this training transferred to real-world

crossing behaviour where pedestrians chose larger gaps in traffic, and were afforded more time to cross the traffic by being less hesitant in their decision making. If pedestrians can be trained to improve their TTC judgements, then it may be possible to use a similar methodology to train drivers to improve their judgements of appropriate gaps for turning in front of motorcycles.

When Harrison (2002) provided feedback to his drivers about the consequences of decisions to turn, he did not use a threshold distance where crash feedback occurred when the approaching traffic was less than the threshold, and safe feedback when the approaching traffic was greater than the threshold. He argued for the random feedback based on associative learning that he used in his experiments because discrimination of the distance threshold for safe and crash responses would be relatively easy and therefore may have reduced interest in the task. This argument seems applicable for photograph stimuli where only distance information is available. However, for video training, accurate feedback based on TTC thresholds is indeed both appropriate and representative of real-world driving tasks.

In real-world driving tasks, there is a threshold time-to-collision where a turn in front of a motorcycle is not safe. This threshold varies as a function of the distance and speed of the approaching motorcycle, and the amount of time needed to cross the intersection (which varies depending on the width of the road and the speed of the car). For motorcycles approaching at higher speeds, larger distances between the driver and motorcycle are required for a turn to be safe, and vice versa. Similarly, larger time gaps between the driver and motorcycle are required for motorcycles approaching from the outside lane of a three lane road than for those approaching on a single lane road. An experimental design based on perceptual learning of appropriate gaps would show simulations of approaching traffic at intersections, and participants would have to judge whether it was safe to turn under conditions where the distance and speed of the approaching vehicles, and the width of the lanes, was systematically manipulated. Based on literature on TTC judgements of approaching motorcycles reported by Horswill et al. (2005) and Caird and Hancock (1994), participants' judgements about appropriate gaps for approaching motorcycles would be overestimates; that is, drivers would choose to turn when the gap to a motorcycle was too small. Feedback based on actual time-to-collision estimates would inform the driver whether a crash or near miss would have occurred, and could be used to facilitate a change in drivers' responses to converge on safe turning judgements.

The benefits of the perceptual learning approach are that the feedback provided does not conflict with factors involved in real-world turning behaviour and its consequences, and therefore the behaviour learned in simulated settings may be more likely to be transferable to real-world driving. This is because the face validity of the feedback in the perceptual learning approach is likely to be much higher than for associative learning – which alone may significantly increase the chances of the success of this approach for training drivers. A further benefit of the perceptual learning approach would be that it would be sensitive to individual differences – only drivers that display incorrect turning judgements for oncoming traffic would require training. However, empirical investigation is required before these claimed benefits are accepted, and a systematic approach to testing the perceptual learning approach is required before it could be formally applied. Of critical importance is the need to demonstrate that any learned responses that might occur in simulated training persist over time, and can be transferred to real-world driving.

In summary, two alternative methodologies for training drivers to give way to motorcycles at intersections have been proposed. The first proposal is for a perceptual learning

methodology that provides feedback to drivers about their responses that is based on the real world factors that lead to intersection crashes. This methodology is more theoretically sound, and training of this form in other related settings has been linked with safer real-world behaviour. The second proposal is to further investigate the usefulness of Harrison's (2002; 2005) approach by collecting data regarding the effectiveness of the associative learning effect using static training stimuli but using a more ecologically valid context of a simulator where feedback is not random, but is provided in the form of successful turns, near misses, or crashes.

6.7 CONCLUSION

Harrison's (2002; 2005) use of associative learning to train drivers to be more likely to give way to motorcycles at intersections was an interesting application of psychological theory to road safety research. Through a series of experiments he was able to demonstrate that, in experimental settings where many of the dynamic cues used in driving were not available to drivers, manipulations of crash risk associated with the presence of a motorcycle at an intersection could be used to change the responses of drivers.

When drivers' responses are made in dynamic contexts that more realistically approach those of real-world driving, such as the videos used in the present study, then random manipulations of crash risk at intersections with motorcycles fails to take into account the complex interactions of factors that can lead to a crash. That is, the presence of a motorcycle per se does not increase crash risk, but rather, crash risk varies as a function of the dynamics of the motorcycle, the skill level of the driver, the presence of other vehicles and objects on the road, and environmental conditions. A driver must take all of these factors into account when deciding whether or not to turn, and a motorcycle crash will occur if the driver turns in front of a motorcycle under conditions where a crash cannot be avoided. In the video task used in the present study, the failure to take into account the above factors when randomly assigning crash risk for approaching motorcycles caused a conflict between feedback and the perceptual experience of the driver. It is likely that this conflict led to the absence of any associative learning effect that would benefit road-safety.

It is recommended that the perceptual learning approach for training drivers to give way to motorcycles at intersections is investigated. This theory is grounded in over 50 years of perceptual research, and training perceptual-related judgements has not only been effectively demonstrated, but has also been linked to safer behaviours in real-world settings. Such an investigation would involve a similar incremental approach as used in the series of associative learning experiments reported to date. That is, the proposal that drivers can be trained to make accurate judgements about whether to turn in front of a motorcycle by selecting sufficient gaps in traffic should be first investigated in PC-based tasks. If it can be shown that perceptual learning does occur, it should then be investigated in terms of whether the learned behaviour is replicated in follow-up tests. Finally, if the learning effect is robust, it should be evaluated using simulation and follow-up analyses of crash risk.

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APPENDIX A

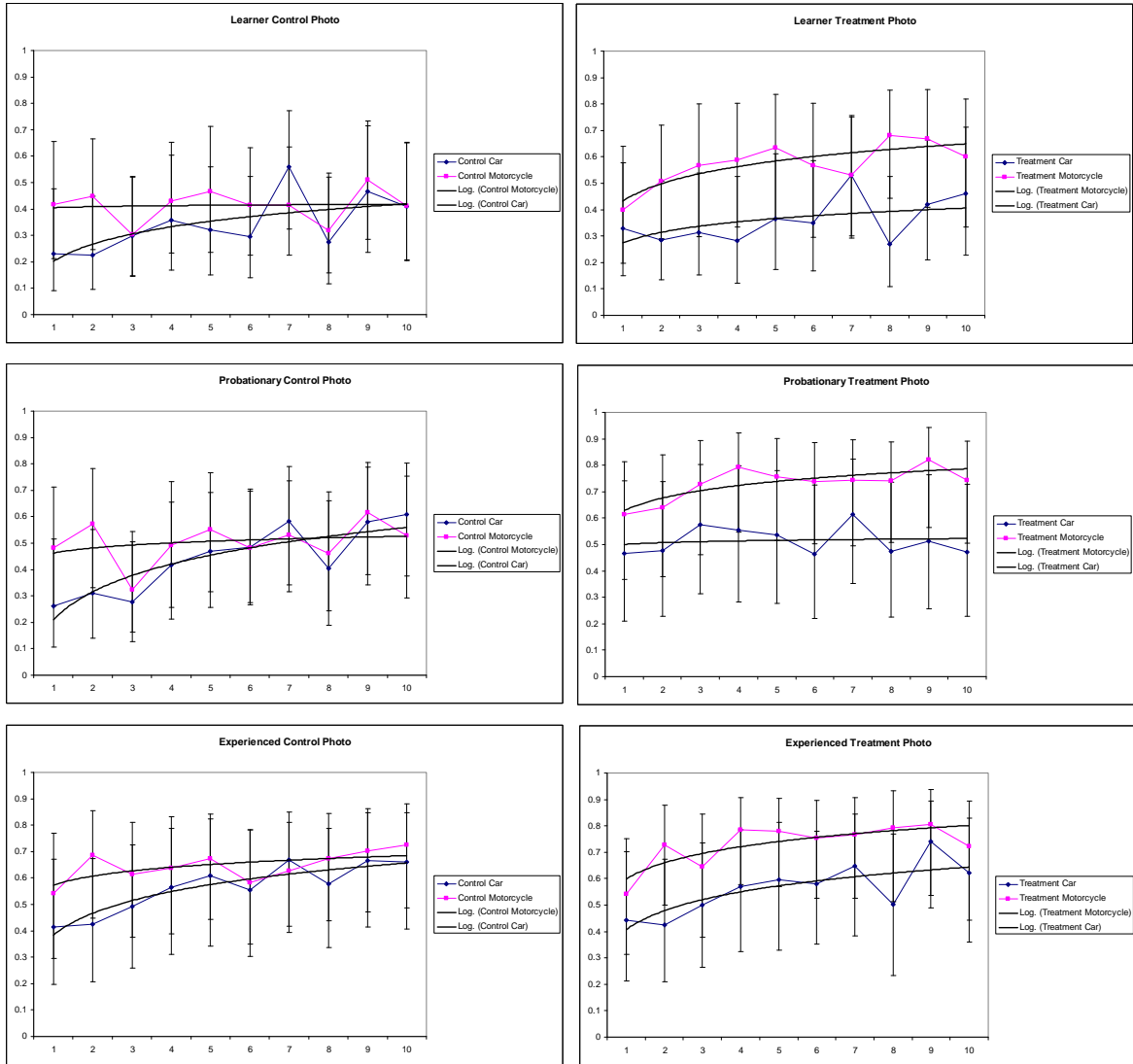


Figure A1. Proportion of wait responses to photographs of motorcycles and cars over blocks of trials, disaggregated by group and driving experience.

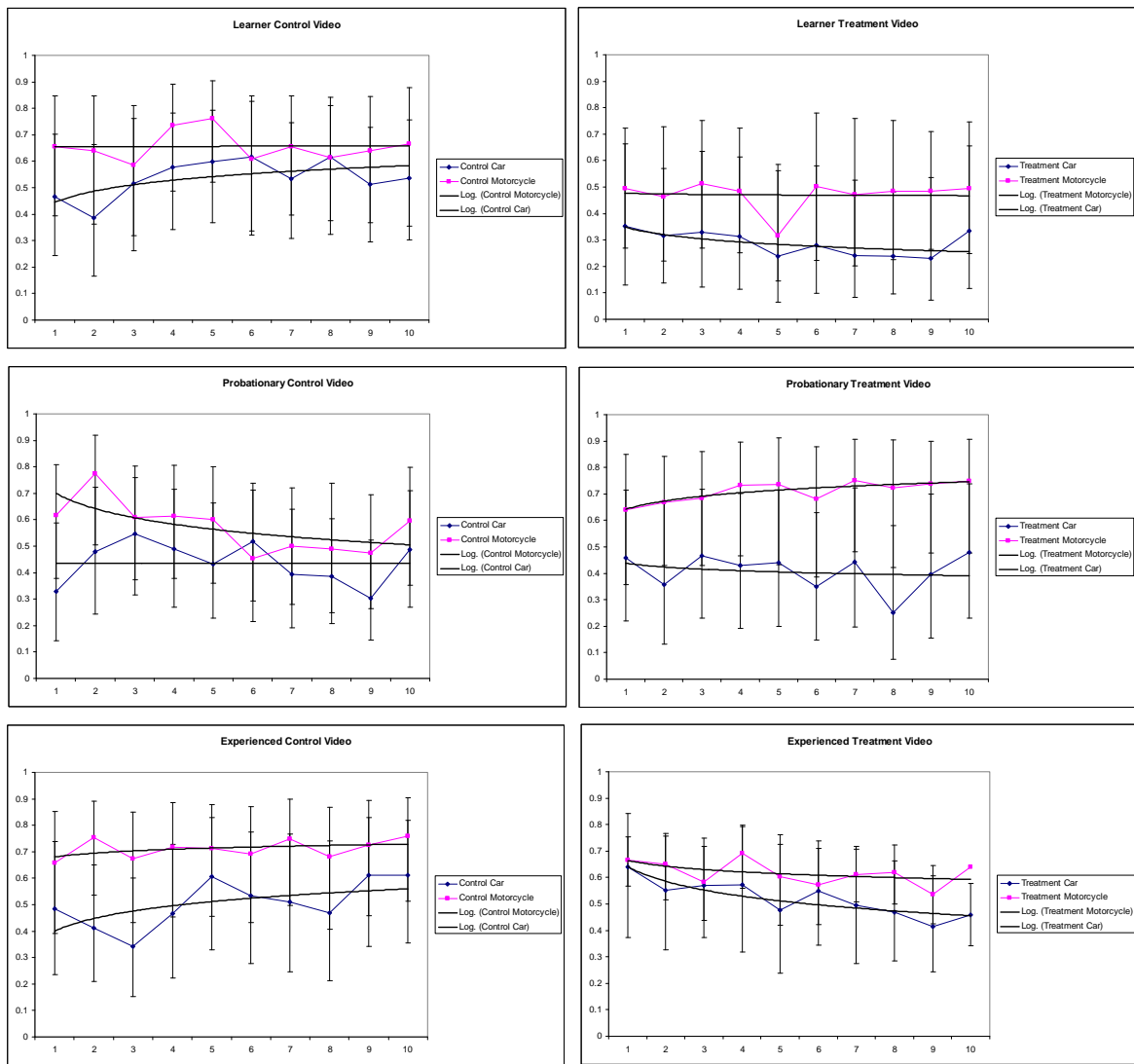


Figure A2. Proportion of wait responses to videos of motorcycles and cars over blocks of trials, disaggregated by group and driving experience.

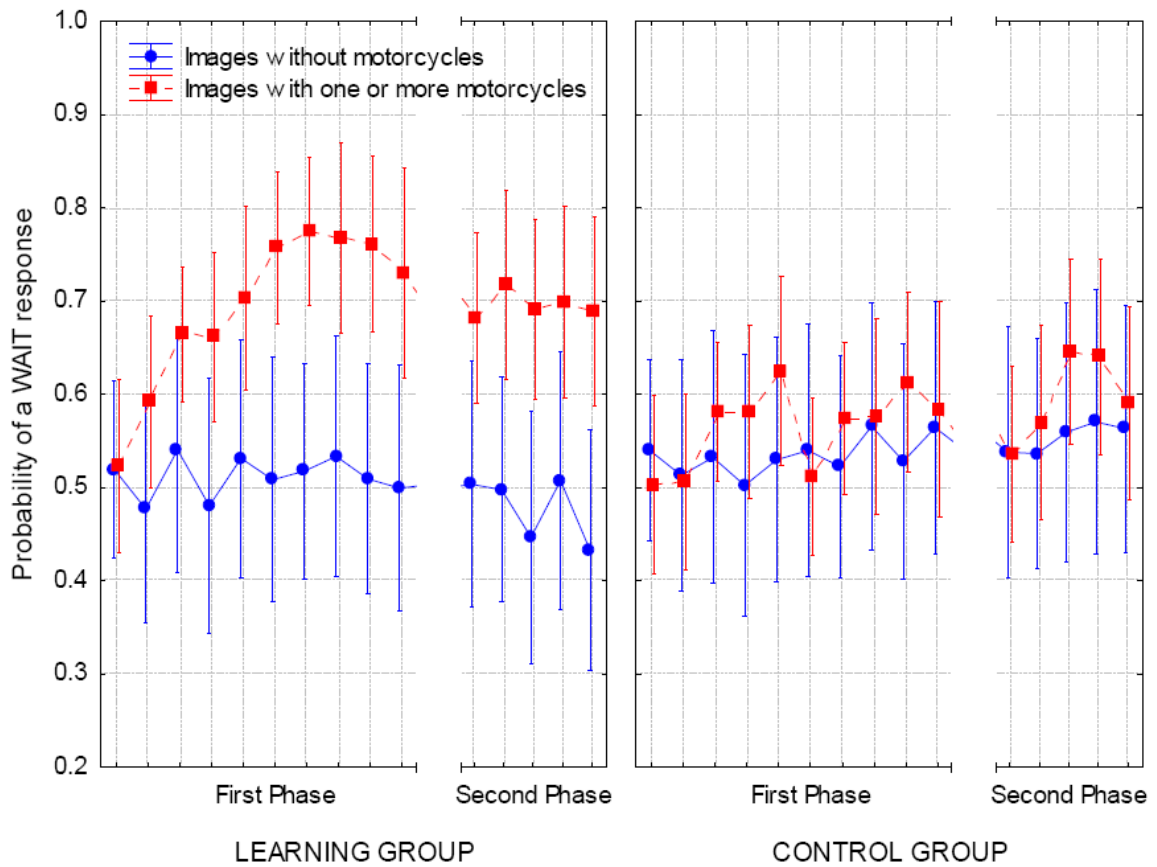


Figure A3. Reproduction of Harrison's (2005) Figure 10. Probability of WAIT responses in the 15 blocks for 20 trials across phases 1 and 2 of the study, disaggregated by Group and Image Content, with 95% confidence intervals. Permission to reproduce this figure supplied by VicRoads

APPENDIX B



INSTRUCTIONS

BACKGROUND

Thank you for agreeing to help with this study. This is your first experiment and must be completed in one sitting. You will also need to complete a second experiment in four weeks time, and a third experiment in twelve weeks time. Please ensure that you write your contact name and email address if we need to contact you.

Please read and sign the consent form before starting the experiment.

The project is concerned with how people make decisions to turn at intersections with different traffic conditions. This study is one of a series of studies that will help VicRoads understand why some crashes at intersections occur.

The project is important and VicRoads will make some decisions about intersection crash programs based on the results – so please do your best and keep in mind that projects of this type do have an effect on road safety programs.

This document includes instructions for starting the experiment, instructions for running the experiment, and instructions on how to save your data when the experiment is finished.

INSTRUCTIONS FOR STARTING THE EXPERIMENT

Your task in all experiments is to look at a series of photos/videos taken at intersections and to imagine that you are sitting in a stationary car waiting to turn right. You are then asked to decide for each one if you would make a right turn across the oncoming traffic or if you would wait.

If you think you would **make the turn**, click on the '**GO**' button.

If you think you would **wait**, click on the '**WAIT**' button.

You have 5 seconds to make each decision, but of course you will finish sooner if you make each decision as quickly as possible.

The computer will work out whether you crashed or completed the turn safely. If you crash, there is a time penalty and the study will take longer for you to complete. There is also a time penalty for clicking on the WAIT button – a bit like real driving where you can save time by going as soon as possible.

You will receive the largest time penalty for not making a decision within 5 seconds – and you will take the longest time to complete the study if you do not respond. You will finish more quickly if you take each opportunity to press the GO button that you can – assuming its safe of course.

There are 200 photos/videos in this experiment – you will have the opportunity for a rest break every 20 photos/videos, but you must complete all 200 photos/videos in one sitting.

INSTRUCTIONS FOR RUNNING THE EXPERIMENT

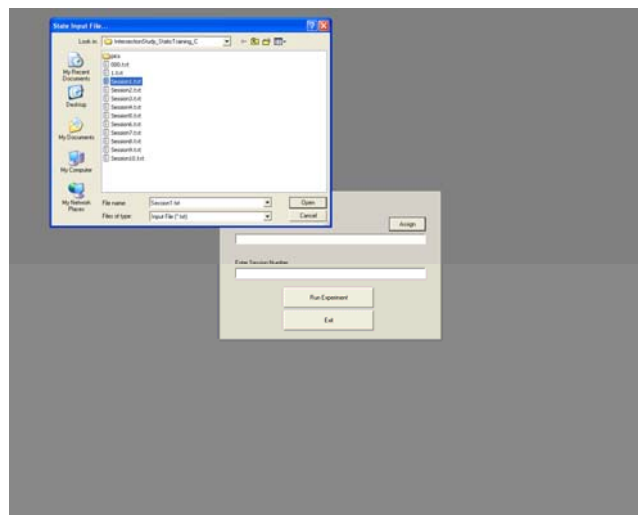
The following instructions explain how to run the experiment.

**FOR THE COMFORT OF OTHERS COMPLETING THE EXPERIMENT,
PLEASE DO NOT TALK OR MAKE ANY EXCESSIVE NOISE WHILE TAKING
PART, AND PLEASE TURN OFF YOUR MOBILE PHONE**



Intersection_Study.exe

1. Double click on the file in My Documents labelled Intersection_Study.exe
2. First you need to state the name of the input file.
3. Click on top box labelled 'assign', and go to My Documents and click on session1.txt.
4. Click on Open.

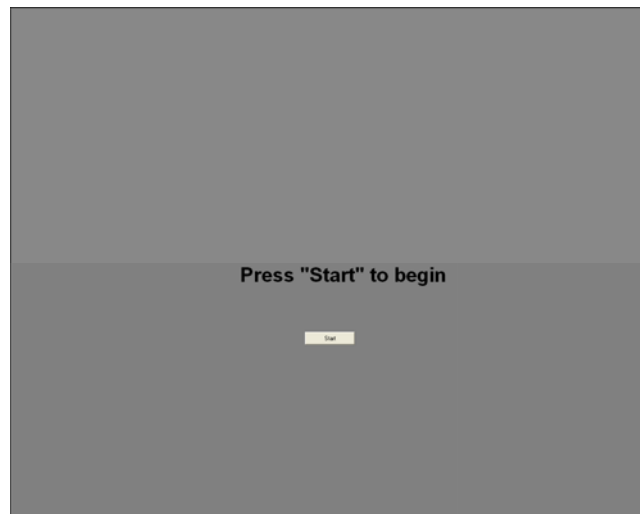


5. Enter the session number (e.g., '1') in the box marked 'Enter Session Number'.
6. Click on the box marked 'Run Experiment'.
7. First you will be asked to complete a brief questionnaire. Please make sure you answer all of the questions. Note that some of the questions will not require answering depending on your experience.

Participant Questionnaire

1. Are you male or female? Male Female
2. What is your age in years?
3. Type of car licence presently held? Full Probationary/Restricted None
 3a. Amount of time current car licence has been held?
4. Do you have a motorcycle licence?
 If you answered "Yes" to the question 4 above, please state:
 4a. Type of motorcycle licence presently held? Full Probationary/Restricted None
 4b. Amount of time current motorcycle licence has been held?
5. Have you undertaken any driver/ride training in the last 10 years?
 If you answered "Yes" to the question 5 above, please state:
 5a. The most recent type of training course you completed?
 5b. In what year did you complete the course?
6. How many hours do you normally spend driving each week?
7. How many kilometres do you travel each year on average?
8. How many official crashes have you been involved in as a driver?

8. Once the questionnaire has been completed, you will be required to complete the first session of the experiment. This will last 20 photos/videos. Press 'START' when you are ready to begin.



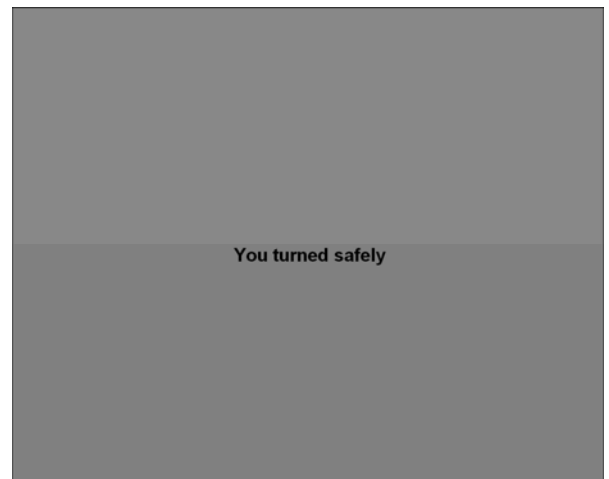
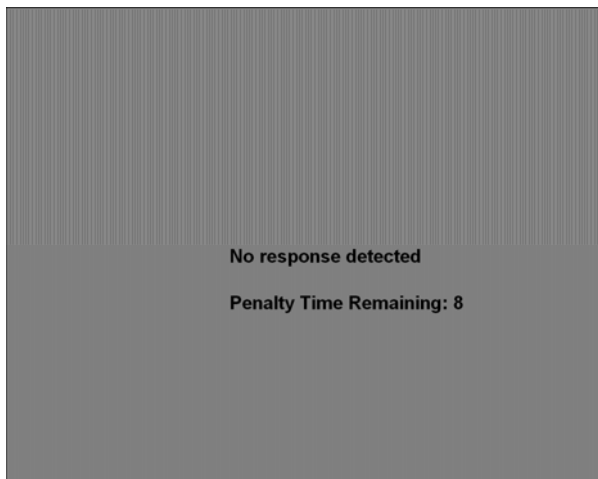
9. You will see a photo/video of approaching traffic and then you must decide if you could make a right turn across the oncoming traffic or if you should wait. If you think you could make the turn, click on the 'GO' button. If you think you should wait, click on the WAIT button.

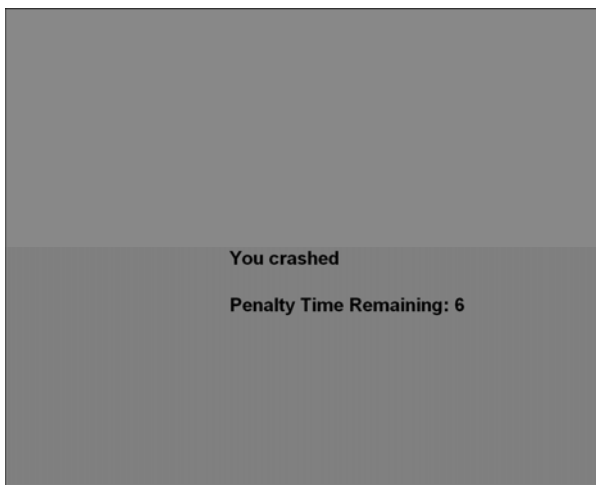


10. The next screen will provide you with feedback about your response. It will indicate you either

- (i) 'TURNED SAFELY' or
- (ii) 'CRASHED' or
- (iii) 'CHOSE TO WAIT' or
- (iv) 'FAILED TO RESPOND'.

For some of your responses, you will also see the time penalty that has been allocated for the choice that you made.





11. After a block of 20 photos/videos, you will see the screen below. Press the EXIT button when you are ready to finish. You can now take a short break.



12. You will need to complete 10 sessions for a total of 200 photos/videos.
13. When you are ready to continue, repeat steps 1-13 above, except that in step 4, click on top box labelled 'assign', and go to My Documents and click on **session2.txt**. Repeat this step each time you are up to a new block of photos/videos making sure you enter the correct session number you are up to.
14. Use the handout to record which sessions you have completed.

INSTRUCTIONS FOR SAVING YOUR EXPERIMENT

15. When you have finished please ask the instructor to save your file onto his/her memory card. Once this has been done, you are free to leave.
16. PLEASE DO NOT TURN OFF, OR LOG OUT OF, YOUR COMPUTER
17. PLEASE LEAVE ALL HANDOUTS at your computer
18. Please note that you will be paid \$45 at the end of the third experiment. The remaining second and third experiments will only take about 20-40 minutes each to complete.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION.